CHAPTER 6 SOURCES AND LOADS OF CRITICAL POLLUTANTS

6.1 Summary

This chapter provides information on the sources and loadings of critical pollutants (i.e. DDT and its metabolites, dieldrin, dioxins/furans, mercury, mirex and PCBs) to Lake Ontario, based on information that existed as of December 2005. This chapter also describes the status of selected actions by LaMP Parties as of December 2005 to address known and potential sources of critical pollutants throughout the Lake Ontario basin, in keeping with the LaMP's sources and loadings strategy.

Critical Pollutants are bioaccumulative and persistent toxic substances that are known or suspected to be responsible for lakewide impairments of beneficial uses: PCBs, DDT & its metabolites, mirex, dioxins/furans, mercury, and dieldrin. These substances are the focus of the Lake Ontario LaMP source reduction activities.

6.2 Identifying Lakewide Problems and Critical Pollutants

The beneficial use impairment assessment from the LaMP Stage 1 Report (1999) identified the lakewide use impairments in Lake Ontario and the toxic substances contributing to these impairments (i.e., those substances for which there was direct evidence of impairment of beneficial uses). It was also considered important for the Lake Ontario LaMP to consider toxic substances which were likely to impair beneficial uses (i.e., there was indirect evidence that these chemicals are impairing beneficial uses if they exceed the most stringent US or Canadian standard, criteria, or guideline). The results from the Stage 1 review in 1999 are summarized below.

Mercury – identified as a LaMP critical pollutant because, although not responsible for consumption advisories on a lakewide basis, mercury concentrations in larger smallmouth bass and walleye frequently exceeded Ontario's fish consumption criteria[1].

Dieldrin – identified as a LaMP critical pollutant because it was found to exceed the most stringent water quality and fish tissue criteria lakewide. Although dieldrin was not causing lakewide impairments of beneficial uses, it was included as a LaMP critical pollutant given the lakewide nature of these criteria exceedences.

PCBs – identified as LaMP critical pollutants because levels of PCBs in Lake Ontario fish and wildlife exceeded human health standards, and because PCB levels in the Lake Ontario food chain may have posed health and reproduction problems for bald eagles, mink, and otter.

Mirex – identified as a LaMP critical pollutant because levels in some Lake Ontario fish exceeded human health standards.

Dioxins and Furans – identified as LaMP critical pollutants because levels of these contaminants exceeded human health standards in some Lake Ontario fish and because these chemicals may

[1] At the time of the Stage 1 Review, the Ontario fish consumption advisory limit for mercury was 0.5 ppm. Health Canada has since *reduced* the tolerable daily intake for mercury for women of child-bearing age and children, but not for the general population. The new tolerable daily intake is temporary, pending the completion of additional long-term study. For women of child-bearing age and children under 15, consumption restrictions for sport fish containing mercury begin at levels of 0.26 ppm with total restriction advised for levels above 0.52 ppm.

limit the full recovery of the Lake Ontario bald eagle, mink, and otter populations by reducing the overall fitness and reproductive health of these species.

DDT and its metabolites – identified as LaMP critical pollutants because they were responsible for wildlife consumption advisories and were identified as a potential problem contaminant for bald eagles as they re-establish their shoreline nesting territories.

Previous Lake Ontario Toxics Management Plan reports had also identified three other contaminants as potentially exceeding water quality standards and criteria: octachlorostyrene (OCS), chlordane, and hexachlorobenzene (HCB). A review of information showed that none of these contaminants persist as a lakewide issue, and that OCS, chlordane, and HCB are well below applicable water quality criteria.

6.3 Lake Ontario Sources and Loadings Strategy

A goal of the Lake Ontario LaMP is to reduce inputs of designated critical pollutants to meet LaMP ecosystem objectives and restore associated beneficial use impairments. Due to the scale and complexity of pollutant sources within the basin, the LaMP agencies agree that a load reduction schedule based on a per cent reduction target is not practical. Instead, the LaMP Parties take a focused and strategic approach to identify, assess and mitigate sources of critical pollutants.

Recognizing that the LaMP Parties have regulatory mandates, the LaMP uses a cooperative approach, working closely with regulatory programs, local governments, industry and individuals to develop and coordinate an effective critical pollutant reduction strategy to address known and potential sources of critical pollutants throughout the Lake Ontario basin. The LaMP critical pollutant reduction strategy has three main elements: (1) data/information synthesis; (2) coordination with regulatory actions; and (3) promoting voluntary actions.

Data/Information Synthesis:

- Information on the concentrations, sources, loadings and pathways of critical pollutants are evaluated, with the aim of identifying source reduction actions.
- Available regulatory monitoring information often does not include critical pollutants in routine monitoring, or may use methods that cannot detect low levels of contaminants of concern. Qualitative information is acknowledged as an important component of the LaMP critical pollutant source identification process and decision making.

Coordination with Regulatory Actions:

- The LaMP identifies and highlights remedial and other regulatory program efforts underway that contribute to LaMP pollutant reduction goals on which LaMP strategies can build.
- Regulatory programs are being kept apprised of any information relevant to their enforcement interests or monitoring requirements, so that regulatory tools can be applied as appropriate to address specific LaMP priority sources.
- Critical pollutants from the upstream Great Lakes and connecting channels enter Lake Ontario via the Niagara River and from out of basin atmospheric sources. Restoring beneficial uses in Lake Ontario depends in part on the successful implementation of LaMPs and RAPs upstream, and out of basin programs that reduce emissions of critical pollutants.

Voluntary Actions:

- The LaMP promotes voluntary efforts to reduce inputs of critical pollutants by: encouraging community and local government pollution prevention programs (such as pesticide "clean sweeps" and mercury equipment/thermometer collections); communicating and highlighting the LaMP goals and objectives and the importance of voluntary efforts (through success stories); and encouraging accelerated product phase-outs, pollutant minimization plans or other actions by industry or local governments.

The LaMP's critical pollutant reduction strategy may go beyond existing programs to address significant sources identified by the LaMP as a binational priority. The US and Canada are using compatible approaches to source reduction strategies in order to best utilize current initiatives, historic actions and individual human and information sources. The US has evaluated critical pollutant information and related actions in all watersheds within its portion of the basin. Canada has focused on actions within priority watersheds, based on available ambient monitoring information and emissions data from industrial, municipal and other non-point source discharges (such as combined sewer overflows, stormwater, waste sites). Local strategies are developed to address identified sources of critical pollutants in these watersheds.

6.4 Identifying Sources and Loadings of Critical Pollutants

Critical pollutants enter Lake Ontario *via* a number of pathways, including its tributaries, precipitation, point sources (e.g., sewage treatment plants, industrial facilities, waste sites) and non-point sources (e.g., urban stormwater, agricultural runoff). Being the last in the chain of Great Lakes, Lake Ontario receives some of its known contaminant loadings from upstream lakes. The sources of critical pollutants to Lake Ontario are defined in the following categories for this report: Upstream (*via* Niagara River); Canadian Tributaries (including Hamilton Harbour); US Tributaries; Canadian Direct Discharges; US Direct Discharges; and Atmospheric Sources (wet and dry deposition plus gas-phase absorption).

6.4.1 Data Sources and Limitations

The approach taken by the Lake Ontario LaMP has been to report all available data regarding loadings to Lake Ontario. The LaMP does not have a formal screening procedure or selection criteria to independently evaluate whether available data are suitable for estimating loadings. The LaMP relies on the advice and conclusion provided by individual agency on whether their data can be reasonably used for quantifying loadings to Lake Ontario.

The LaMP provides estimated loading data in Table 6.1 with the caution that management decisions should not be based solely on these comparative loadings. Confidence in many of these data is low, and the potential for errors is high. Comparing the magnitude of loadings from one source to another is confounded by differences in sampling methods used by the various agencies that collect these data. Analytical methods have changed over time, and agencies have adopted new methods at varying times. The reporting of analytical results is not consistent between programs either; concentrations of contaminants from some sources may be "below the detection limit," and the methods used to handle these censored data differ between monitoring programs. Data presented in Table 6.1 were collected at different times over a 15-year time frame. Confidence and recognized limitations specific to each source are described below.

Where acceptable quantitative loadings information is not available, qualitative indicators provided by water quality monitoring, or by other monitoring such as sediment and aquatic organisms, have been used to identify contaminant sources.

6.4.1.1 Sources Within the Lake Ontario Basin

Point Sources

New York State requires wastewater dischargers to monitor and report on known or suspected contaminants. Discharge permits include specific parameter limits and are designed to address toxicity testing, pollution prevention, pretreatment, and compliance schedule requirements. A Pollutant Minimization Program (PMP) guidance manual for wastewater treatment was completed in 2004 to focus on mercury and other toxic discharge reductions (see Section 6.5.2.2)

The Toxics Release Inventory (TRI) is useful in summarizing the annual release of toxic chemicals reported by certain industrial facility groups. Reports for 1997 through 2000 are posted on NYSDEC's website. Release to receiving waters accounts for about 15 per cent of the total inventory. TRI data are not used for calculating US point source loadings to Lake Ontario in Table 6.1, but rely instead on a NYSDEC study from 1997 (Litten, 1997).

On a national basis in Canada, information on point source releases of mercury, dioxins and furans to water are included in the National Pollutant Release Inventory (NPRI). Facilities are able to report loadings that are based on monitoring or direct measurement, mass balance calculations, emission factors or other engineering calculations. However, the criteria for reporting to this program are such that an unknown number of smaller direct point sources are not captured. NPRI data are used for calculating Canadian point source loadings of mercury to Lake Ontario in Table 6.1, with one exception noted below.

Ontario's Municipal/Industrial Strategy for Abatement (MISA) regulations require nine industry sectors to report concentrations and loading of toxic contaminants, including dioxins (2,3,7,8 - T4CDD) and furans (2,3,7,8 - T4CDF). In 2004, no facilities reported concentrations of dioxins and furans above the detection limit. Through facility-specific approvals, OMOE requires some facilities to report loadings of mercury. In 2004, one facility did report loadings of mercury, and these data are used in lieu of NPRI's data for that facility in calculating the summary shown in Table 6.1.

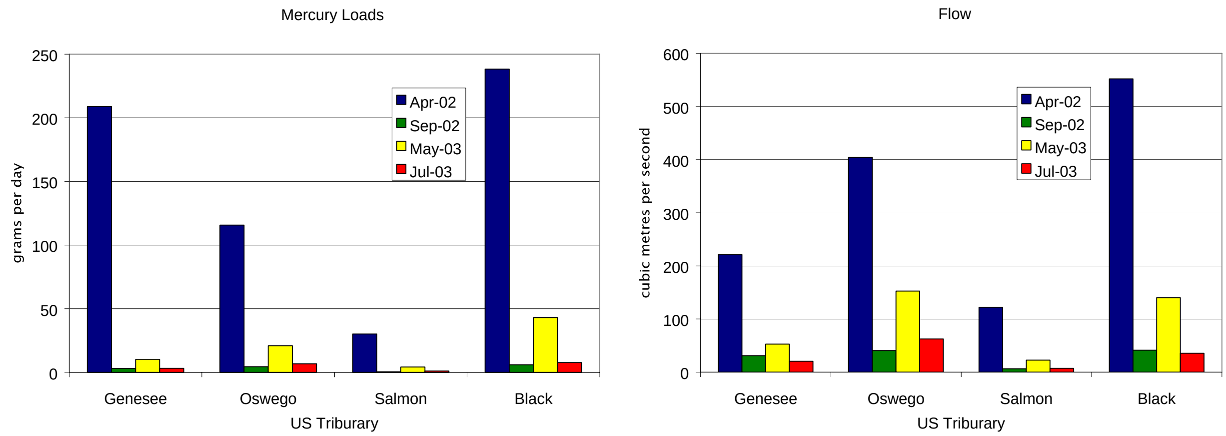
In the fall of 2004, OMOE launched a sampling program at selected landfill sites and municipal sewage treatment plants to characterize harmful pollutants in landfill leachate and municipal influent, effluent and sludge. The results from this sampling program will help to characterize harmful pollutant loadings to Lake Ontario, as well as inform policy development for the control of these pollutants in municipal effluent. The study consists of a one-year sampling program which was continued until November 2005. Lab analysis of these samples is currently being conducted.

Tributaries

In order to calculate the total loading of any pollutant being carried by a tributary, it is necessary to know both flow (i.e., the total volume of water flowing out of the tributary) and the concentration of the pollutant in the river. In the spring, or after several days of heavy rain, flow can increase dramatically, with a corresponding increase in loading, due to increases in sediment carried in the river, or because of the increased runoff entering the river. These changes can cause large variations in loadings, as seen in Figure 6.1.

Critical pollutants entering tributaries may originate from a number of sources or activities (such as point sources, atmospheric deposition onto the watershed, contaminated industrial sites, landfills, historic use of pesticides, storm drainage, combined sewer overflows, etc). Therefore, pollutant concentrations can be highly variable. Ideally, in order to accurately estimate loadings of critical pollutants, there should be frequent data covering the range of seasons and flow conditions. However, due to logistical constraints, this is often not possible. As a result, available quantitative and qualitative monitoring data, as well as biological monitoring results, were used to estimate loadings, or the relative presence or absence of critical pollutants within each tributary watershed.

Figure 6.1 Variations in flows and loads of mercury in US Tributaries



US tributary loadings presented in Table 6.1 are calculated differently than Canadian tributary loadings. The USEPA's data are, at this time, based on approximately eight sampling events per tributary. These are the best available estimates and are subject to changes as additional data become available and as monitoring techniques improve. These loading estimates for tributaries should be considered qualitative and approximate, as sampling in most cases was not event-based. The data that are provided are only estimates, and are subject to significant changes in the future.

Canadian tributary loading estimate protocols from OMOE requires a larger number of samples to estimate contaminant loadings. This protocol was the basis for work in Toronto-area tributaries in 1991 through 1992, and only these Toronto-area tributaries are used to estimate contaminant loads from Canadian tributaries in Table 6.1. The magnitude of the remaining loadings cannot be quantified.

In-place Sediments

The LaMP is not currently reporting estimates from loadings to Lake Ontario water from in-place sediments. The LOTOX2 model, discussed subsequently in this chapter, uses modeling techniques to estimate the loadings of PCBs from in-place sediment that have occurred historically (see Section 6.6.1.4)

Other In-Basin Sources

This assessment does not include information on combined sewer overflows (CSOs), stormwater and other non-point sources that discharge directly to the lake. The magnitude of these missing loads cannot be estimated based on current data.

Loadings from air emissions sources within the basin, versus those from air emissions sources *outside* the basin, cannot currently be differentiated, although modelling and other research is ongoing in this area. See Atmospheric Deposition (section 6.4.1.3) below.

6.4.1.2 Sources and Releases Outside the Lake Ontario Basin

Long-term water quality monitoring programs are conducted by Environment Canada at Fort Erie and Niagara-on-the-Lake (at both ends of the Niagara River). These programs use similar sampling and analytical methods and the loading calculation methodologies have been agreed to by the LaMP Parties.

These data provide a good estimate of the critical pollutant loadings that originate from upstream Great Lakes basins, and those that originate in the Niagara River basin, and are summarized in Table 6.1.

The amounts of critical pollutants that leave Lake Ontario via the St. Lawrence River are monitored at Wolfe Island at the head of the St. Lawrence River. While data collection at this station is ongoing, Lake Ontario's loadings to the St Lawrence River have not been compiled into updated estimates, and 1997 data are reported in Table 6.1.

6.4.1.3 Atmospheric Deposition

Estimates of atmospheric loadings of critical pollutants to Lake Ontario were developed by the Integrated Atmospheric Deposition Network (IADN) for PCBs, DDT and dieldrin. IADN is an international network of seven master air sampling stations located throughout the Great Lakes basin and has measured levels of persistent chemicals in the air since 1991. The IADN network for Lake Ontario consists of a master station at Point Petre (near the eastern end of Lake Ontario), and a satellite station located in Burlington, Ontario (at the west end of the lake). As in previous LaMP reports, IADN data are used in Table 6.1 to report atmospheric deposition of PCB and pesticide critical pollutants; new for this report are mercury loading information.

In past IADN reports, flows and fluxes were calculated seasonally and then summed to give annual loads and averaged to give annual fluxes. Loadings estimates of dry and wet deposition and absorption are now calculated monthly. Volatilization estimates are calculated annually by IADN, although IADN does not measure water concentrations and must rely on other researchers' measurements.

In IADN's report, errors are presented for each term as a coefficient of variation (COV). Because monthly loadings estimates are now calculated and only two or three values were available, the standard deviation over mean as a measure of uncertainties for ambient air concentrations was not used. Instead, limit of detection over mean was adopted. This has resulted in slightly smaller overall COVs since temporal variability was one of the major sources of error in previous reports. Readers are referred to *Atmospheric Deposition of Toxic Substances to the Great Lakes: IADN Results Through 2000* for parameter-specific COVs (Blanchard *et al*., 2004).

IADN results are included with results from the Lake Ontario Atmospheric Deposition Project (LOADS) project, which provides estimates of atmospheric loadings of mercury (elemental and reactive gaseous), PCBs, DDE, mirex, and dioxins/furans. LOADS sampling occurred every six days for a period of twelve months at a site on the shoreline of Lake Ontario in Sterling, New York, along with three one-week cruises aboard the Lake Guardian. Land based sampling at Sterling, New York is still underway.

6.4.2 Loadings – General

Table 6.1 presents four major categories of critical pollutant loadings estimates based on the best data available in 2005. Again, as a result of the many limitations described previously, the loading numbers in Table 6.1 are only estimates.

Table 6.1 Estimates of Critical Pollutant Loadings to Lake Ontario

Note: Loadings in this table are only ESTIMATES. The data are drawn from a number of different sources and monitoring programs which use different criteria, methods, and loading calculation methodologies. As a result, these estimates contain a significant degree of uncertainty and should only be considered as general indications of the current state of the LaMP's Parties knowledge of the significance of loadings from various sources. Data sources are provided on the next page.

Data Year	Loadings from Sources Upstream of the Lake Ontario Basin MEAN (Lower 90 percent CI to Upper 90 percent CI) kg/yr						Loadings from Water Discharges within the Lake Ontario Basin kg/yr					Loadings from the atmosphere kg/yr		Amounts Leaving Lake Ontario kg/yr		
	Other Great Lakes		Niagara River Basin		Total		Tributaries MEAN (+/-RMSE)		Direct Point Sources Discharges		Total	LOADS	IADN	Via St. Lawrence River	Loss to Atmosphere	
							Can.	US	Can.	US					LOADS	IADN
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1991-1998	2002-2004	2003	1997		2005	2000	1995	2005	2000
PCBs	16 (13 to 21)	30 (19 to 47)	61 (37 to 90)	11 (-16 to 35)	77 (58 to 103)	41 (31 to 54)	3.6 (2.7 to 4.5)	11	NA	1.6	19.7	NQ	45	NQ	NQ	320
Total DDT	19 (15 to 25)	22 (13 to 40)	-9.7 (-19 to 2)	-13 (-34 to 0)	9.3 (5.8 to 17)	9.2 (6.7 to 13)	1.1 (0.8 to 1.4)	ND	NA	1.7	2.6	NQ	22	1.1	NQ	NA
Mirex	ND	ND	1.5 (0.9 to 2.5)	0.9 (0.7 to 1.2)	1.5 (0.9 to 2.5)	0.9 (0.7 to 1.2)	NQ	ND	NA	ND	0.004	NQ	ND	NA	NQ	NA
Dieldrin	17 (16 to 19)	20 (18 to 23)	-1 (-4 to 1)	-4 (-11 to 3)	16 (14 to 17)	16 (12 to 21)	0.3 (0.27 to 0.33)	ND	NA	0.15	0.35	NA	24	40	NA	190
Dioxins/Furans	ND	ND	ND	ND	ND	ND	NQ	ND	ND	ND	NQ	NQ	NA	ND	NQ	NA
Mercury	93 (86 to 99)	119 (95 to 150)	-22 (-39 to -2)	-71 (-110 to -36)	71 (60 to 84)	49 (40 to 59)	NQ	53	68	3.5	124.5	558	185	ND	410	157

NA = Not Analysed – no data are available
ND = Not Detected – concentration data are available, but are below analytical detection limits
NQ = Not Quantified – parameter is detected, but only qualitative data are available
RMSE = Root Mean Square Error
CI = Confidence Interval

Data Sources for Table 6.1

Loadings from Sources Upstream of the Lake Ontario Basin

- Klawunn, P. *et al.,* 2005 (unpublished). The Niagara River Upstream/Downstream Program. Ecosystem Health Division, Environment Canada – Ontario Region. Values are for 1999/2000 and 2000/2001.
- **N.B.** Values for Niagara River Basin estimated based on measured results at Niagara-On-The-Lake (total) minus Fort Erie (other Great Lakes). Upper and Lower Confidence Intervals Physical and chemical processes within the Niagara River (e.g., volatilization to air , deposition to sediment) may be in part responsible for reported 'negative' loadings), as may inaccuracies inherent in calculating loadings.
- **N.B.** Mercury measurements did not include particle-bound mercury.

Loadings from Water Discharges within the Lake Ontario Basin
Direct Point Source Discharges – Canada

- 2003 NPRI National Databases

Direct Point Source Discharges – US

- Litten, 1997. NYSDEC; New York State SPDES program.

Atmospheric Loadings

- Blanchard et al., 2004. Atmospheric Deposition of Toxic Substances to the Great Lakes: IADN Results to 2000, US/Canada IADN Scientific Steering Committee. Values for PCBs, DDTs and Dieldrin are for 2000 and represent wet deposition (via precipitation and gas absorption).
- Holsen, T. Estimation of Mercury Loadings to Lake Ontario in the Lake Ontario Atmospheric Deposition Study (LOADS) (in press) Hg loading is comprised of : atmospheric loadings into the lake = 300 (Hg_0) + 170 (wet deposition) + 68 (RGM) + 20 Hg (p) = 558 kg/yr. Hg load leaving the lake thru loss to atmosphere = 410 kg/yr (DGM)

Point and Non-Point via Tributaries - Canada

- Boyd, D. and H. Biberhofer, 1999. Large Volume Sampling at Six Lake Ontario Tributaries During 1997 and 1998
- Boyd, D. 1999. Assessment of Six tributary Discharges to the Toronto Area Waterfront. Volume 1
- Boyd, D. D'Andrea, M. Anderton, R. 1999. Assessment of Six Tributary Discharges to the Toronto Area Waterfront. Volume 2.
- Fox, M.E. R.M. Khan and P.A. Thiessen. 1996. Loadings of PCBs and PAHs from Hamilton Harbour to Lake Ontario. Water Quality Research Journal of Canada, 31(3): 593-608. **N.B.** This study involved a 10-day sampling period in July 1990 and a 14-day sampling period in March 1991. Annual loadings of 2.8 kg/ year of PCBs were calculated. However, those data are not included in the totals above.

Point and Non-Point via Tributaries – US

- Coleates, R., *et al*. 2005. Means of Total Loadings from Five Tributaries , calculated from concentration and flow data from sampling events between April 2002 and September 2004 for Eighteen Mile Creek, Genesee River, Oswego River, Salmon River and Black River (unpublished, United States Environmental Protection Agency).

St. Lawrence River

- Merriman, J., 1998. Trace Organic Contaminants in the St. Lawrence River at Wolfe Island. (1994-1995).
- **N.B.** Previously, PCBs discharged from Lake Ontario at Wolfe Island were calculated at 360 kg/yr. Subsequently, it was determined that PCB measurements made at Wolfe Island were influenced by lab contamination, resulting in reported PCB concentrations that over-estimated actual values by as much as a factor of two for current levels. Data for Wolfe Island will be updated by the LaMP as soon as the final data are available.

6.4.3 Loadings of Critical Pollutants

The LaMP previously reported that, based on the very limited loadings data available, the most significant source of critical pollutants to Lake Ontario comes from outside the Lake Ontario basin, specifically the Niagara River Basin and upstream lakes. Based on the current, although still very limited loadings data available, it appears that the upstream Great Lakes are still a significant source of critical pollutants to Lake Ontario. However, for some critical pollutants, the loadings from atmospheric deposition, whose source is from activities both within and outside the Lake Ontario basin, is equal in magnitude to loadings from upstream Great Lakes.

6.4.3.1 PCBs

Polychlorinated biphenyls (PCBs) were manufactured between 1929 and 1977. PCBs were considered an important industrial safety product for conditions where high heat or powerful electric currents posed explosive and fire hazards. PCB oils were used in electrical transformers as a nonflammable electrical insulating fluid. PCBs were also used as industrial lubricating oils to replace earlier types of hydraulic oils that could more easily catch fire under conditions of high pressure and temperature. Since the 1970s, the production of PCBs in North America has been banned, and the uses of PCBs are being eliminated.

Levels of PCBs in the environment have decreased in response to the banning and phasing out of the various uses of PCBs. The Great Lakes Binational Toxics Strategy (GLBTS, 2004) indicates that 88 per cent of high-level PCB wastes in storage in Ontario had been destroyed compared to a reduction target of 90 per cent. The USEPA has committed to reassess the PCB equipment inventory in 2005 in order to report progress towards its GLBTS challenge goal of a 90 per cent national reduction of high-level by 2006.

Upstream loadings of PCBs from the NRTMP have changed significantly since 2002; however, this change is in part due to protocol changes in the laboratory analysis. Beginning in April 1998, PCBs in water and solids were analyzed as individual congeners, and reported as total congener PCBs (TCPCB) using capillary columns chromatography. Prior to this date, total PCBs were analyzed and reported based on a 1:1:1 mixture of Aroclors 1242, 1254 and 1260 using packed column chromatography. A comparison of the two methods shows that the new capillary column method results in higher PCB concentrations reported in both water and suspended sediments. Therefore, it is not possible to compare the results of the methods used prior to April 1998 to results after this date.

6.4.3.2 DDT and its Metabolites

DDT was the most widely used pesticide in North America and other countries from 1946 to 1972. Agricultural use of DDT has since been banned in North America following a determination that DDT and its breakdown products were causing widespread reproductive failures in eagles and other wildlife species.

The IADN data indicate that atmospheric deposition of DDT has fluctuated in Lake Ontario from 1993 through 2000, with deposition lower in 1998 to 2000 than in the proceeding years. IADN does not track loss from the lake through volatilization.

6.4.3.3 Mirex

Mirex was used in the Lake Ontario basin primarily as a flame retardant in manufacturing and electrical applications. Use and production of mirex is now banned in North America. During the 1970s, a manufacturer discharged large quantities of mirex-contaminated wastewater to the Niagara River, resulting in widespread contamination of Lake Ontario sediment and fish.

The only measurable mirex that enters Lake Ontario originates in the Niagara River basin. However, the Niagara River Upstream/Downstream water sampling program operated by EC shows substantial decreases in the concentrations of mirex.

Two facilities located on the Oswego and Credit Rivers, which used mirex in the 1970s, have been extensively investigated as there were concerns regarding known or potential mirex releases to these rivers. A review of 1999 information, including mirex levels in resident fish, indicated that the Oswego and Credit Rivers are not significant sources of mirex to the lake.

No reliable estimates of atmospheric deposition or volatilization of mirex are yet available.

6.4.3.4 Dioxins and Furans

Dioxins and furans are a group of chemical by-products that are created by a variety of chemical and combustion processes. Steps have been taken to control and limit those processes that produce high levels of dioxins and furans, resulting in a significant decrease in environmental levels of these chemicals over the last two decades. Some of the processes that continue to produce dioxins and furans include wood burning stoves, internal combustion engines, incinerators, and a variety of other chemical processes. Natural sources, such as forest fires, also produce dioxins and furans.

Dioxins and furans exist at very low levels in the environment and, as a result, are difficult and costly to detect and accurately quantify. Historically chemical manufacturing sources in the Niagara River Basin were significant sources of these contaminants to Lake Ontario. These sources have been effectively controlled, although low-level releases to water from one Ontario site to the Niagara River Basin are reported to Canada’s National Pollutant Release Inventory.

Although the Niagara River upstream-downstream program did not detect dioxins and furans in Niagara River water, information from other media (mussels, spottail shiners) do confirm low-level releases of dioxins and furans along the Niagara River. Using the same types of qualitative water and biological sampling methods, dioxins and furans have also been detected in some Lake Ontario tributaries and harbours.

Air emissions are recognized as an important source of these contaminants to the environment. High volume air samples have been collected and analyzed through the Lake Ontario Atmospheric Deposition Study (LOADS). A summary of results of the concentrations of dioxins/furans in the air over the lake and at a land-based site is shown in Table 6.5. The estimated load to the lake will be done by LOADS, but is not available at this time.

The US and Canada are well advanced toward meeting their Great Lakes Binational Toxics Strategy dioxin/furan emission reduction goals. The BTS reported that the US projected that it has met its challenge goal of 75 per cent reduction of the aggregate of air releases of dioxins and furans nationwide, and water releases within the Great Lakes basin. Canada, which estimates an 87 per cent reduction of releases to air and water within the Great Lakes basin, expected to meet its 90 per cent target by the end of 2005.

6.4.3.5 Mercury

Mercury is a naturally-occurring metal, which is found in small amounts in most soils and rocks. Mercury is used in medical and dental products, electrical switches, batteries and in the production of various synthetic materials, such as urethane foam.

The upstream loading data presented for 2005 are changed from the LaMP's 2002 reporting year. Previously, mercury loadings from the Niagara River were estimated based on values for particle and dissolved-phase concentrations for mercury at the analytical detection limit. In Table 6.1, Niagara River data are presented based on analysis of mercury in suspended solids only; future years will include dissolved-phase mercury in the water column as well.

With respect to mercury point source water discharges from the Canadian-side, data in Table 6.1 are based on reports to the NPRI The NPRI reporting criteria for mercury is such that only facilities that manufactured, processed or otherwise used five kilograms or more of mercury (at any concentration) are required to submit a report. Therefore, Table 6.1 under-reports the point source mercury emissions to Lake Ontario. Mercury loadings from point sources in the US have not been re-quantified since 1997, and methodological improvements as well as improvements in sewage treatment plant operation and efficiency suggest that these data should be considered cautiously.

Atmospheric deposition of mercury to Lake Ontario results from sources from both within and outside of the lake's drainage basin, including loadings from U.S., Canadian and international sources. The question of whether reductions within the Lake Ontario basin and other North American emissions reductions are offset by global emissions increases is an area of research.

The USEPA has renewed tributary sampling of the Genesee River, 18 Mile Creek, Oswego River, Salmon River and the Black River during the period 2002 through 2005. These data are reported here as the loadings from U.S. tributaries from 2002 through 2004. Monitoring is expected to continue for the near future, and should improve the reporting of loadings from these tributaries. Smaller creeks that were not previously sampled will also be added to the monitoring regime. Estimated loadings will be updated as new data are available.

6.4.3.6 Dieldrin

Dieldrin is a formerly used pesticide that is now banned from use in the Lake Ontario basin and throughout North America. Aldrin, another formerly used pesticide, transforms into dieldrin through natural breakdown processes.

Most of the dieldrin that enters the lake comes from upstream sources and atmospheric deposition. Gas exchange of dieldrin at Lake Ontario is consistently the largest flux observed, indicating net volatilization (loss) of this pesticide.

6.5 Actions and Progress

The information contained in this chapter has been compiled based on documents produced up to December 2005. The LaMP process is a dynamic one and therefore the status will change as progress is made.

It should be recognized that programs in place today that have or will reduce critical pollutant loadings may not have an impact on environmental levels for decades, particularly in fish and wildlife. Organisms accumulate chemicals or metals that have been in the ecosystem for long periods of time, either in sediment or in organisms which are lower on the food chain. This time lag must be considered when evaluating data which were often collected several years before being reported and which reflect loadings which occurred many more years before data collection.

6.5.1 Binational Activities

6.5.1.1 Niagara River Toxics Management Plan

Because of the critical link between Lake Ontario and the Niagara River, the Four Parties agreed in 1987 to implement the Niagara River Toxics Management Plan (NRTMP). The NRTMP works to “reduce toxic chemical concentrations in the Niagara River by reducing inputs from sources along the river with a goal of achieving water quality that will protect human health, aquatic life, and wildlife, and while doing so, improve and protect water quality in Lake Ontario as well.” Eighteen priority toxics were identified and 10 (including Lake Ontario LaMP critical pollutants dioxin, mercury, mirex, and PCBs) were selected for 50 per cent reduction. To do this, the Four Parties committed to: 1) reduce point and non-point sources of pollution to the river; 2) monitor the water quality and health of the river; and, 3) report progress to the public.

Since 1987, significant improvements in the river have been made by completing site specific clean-up activities, controlling point source discharges, encouraging pollution prevention techniques and restoring critical habitat areas along the river. A Letter of Support was signed by the Four Parties on December 3, 1996, to continue the commitment to the Declaration of Intent and to further actions to reduce loadings of toxic chemicals to the Niagara River.

Improvements, as shown by the ongoing results of monitoring contaminants in river water, tissues of fish or mussels and river sediments are reported in Niagara River Toxics Management Plan Progress Report and Work Plans (e.g. Williams and O’Shea, 2004; Williams and O’Shea, 2003). Included in these reports are summaries of the Niagara River Upstream/Downstream program, including the Williams et al. (2000) summary describing trends in contaminant reductions over the period of 1986-1997, and the ongoing monitoring program reports (e.g., Merriman and Kuntz, 2002).

6.5.1.2 Lake Ontario Air Deposition Study (LOADS)

The LOADS project is a multi-year collaboration to study the levels of mercury, polychlorinated biphenyls (PCBs), dioxins/furans, mirex and dichloro-diphenyl-dichloroethylene (DDE) that deposit from the air into the lake. Scientists and agency personnel from Clarkson University, SUNY Oswego, SUNY Fredonia, University of Michigan, Environment Canada, New York State Department of Environmental Conservation and the US Environmental Protection Agency are taking part in the study.

The objectives of the study are to: 1) estimate contaminant loadings being deposited from the air into the lake. (This information will be integrated into the Lake Ontario Mass Balance Model, a mathematical model that predicts what effect reducing pollution will have on the lake and its fish (see Section 6.5.1.4)) ; 2) assess any differences in concentrations and deposition over land and over water; and, 3) examine the effect of urban areas on deposition to the lake.

During 3 intensive sampling events, samples of air and water were taken from the Environmental Protection Agency (USEPA) research vessel Lake Guardian during April and September 2002 and July 2003 cruises. At the same time, samples were collected at the land-based site at Sterling, NY. Sampling was coordinated with the IADN Pt. Petre, Ontario sampling schedule.

The land-based site operated by SUNY Oswego is located at Sterling Nature Center, Sterling, NY and is situated on a bluff overlooking Lake Ontario. The site samples for air deposition for PCBs, dioxins/furans, DDE, mirex, reactive gaseous mercury (RGM) and total gaseous mercury (TGM).

At Sterling, samples were collected every six days from April 2002 to March 2003, matching the sampling protocols of the Integrated Atmospheric Deposition Network (IADN). The closest IADN site to Sterling is located at Pt. Petre approximately 50 miles (30 km) across Lake Ontario on the northeastern shore. Prior to the LOADS project no dedicated measurement of airborne contaminants was occurring on the southeastern shore of Lake Ontario.

PCB Results

Table 6.2 PCB air concentrations, pg/m3 and air temperature. Sampled from Ship and from nearby Land based station. Average of three intensive sampling events (April and September 2002 and July 2003)

Sampling Location	R/V Lake Guardian (pg/m^3)	Temperature (°C)	Land based Sterling, N.Y. (pg/m^3)	Temperature (°C)
L1	226	16.8	450	17.7
L2	156	15.8	601	19.5
L3	148	17.6	583	20.8
L5	203	14.2	443	20.2
L6	216	16.5	321	16.5
L6-D	366	17.0	588	22.3
L6-N	350	18.3	323	19.3

L1 = eastern basin between Pt. Petre and Oswego
L2 = eastern basin mid lake north of Rochester
L3 = middle of lake
L4 = middle of lake
L5 = off shore of Toronto
L6 = off Hamilton Harbor
L6 –D = off Hamilton Harbor sampled in daytime
L6 –N = off Hamilton Harbor sampled at night

For the period April 2002 – March 2003 over 200 samples were extracted and analyzed for PCBs. The following general statements can be made:

- Levels of atmospheric total PCBs measured on the southeastern shore of Lake Ontario at Sterling for the period 2002-2003 are higher than similar rural sites on the Great Lakes as reported by IADN between the years 1998-2000 (Figure 6.2).
- The pattern of PCBs measured at Sterling is markedly different than any of the other IADN sites, consisting of more higher-chlorinated PCBs.
- Air sampling conducted on Lake Ontario during three cruises aboard the RV Lake Guardian indicate that Lake Ontario is not the source of the higher-chlorinated PCB fingerprint measured at Sterling.
- Land-based sampling conducted at Sterling for the period 2002-2003 indicates that the amounts of PCBs found in the air are directly linked to air temperature, that is, as the air temperature increases the amount of PCBs in the air also increases (Figure 6.3)

Figure 6.2 Total PCB comparison of IADN (1998-2000) and Sterling (2002-2003)

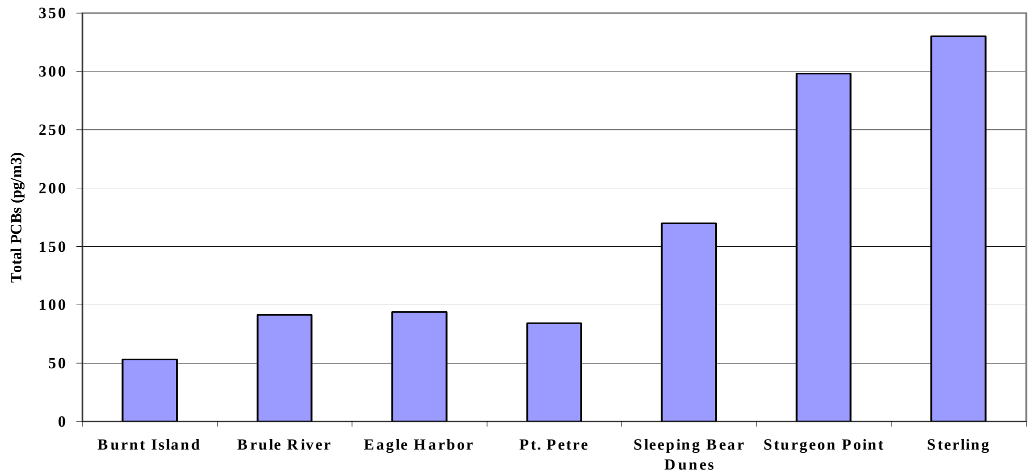
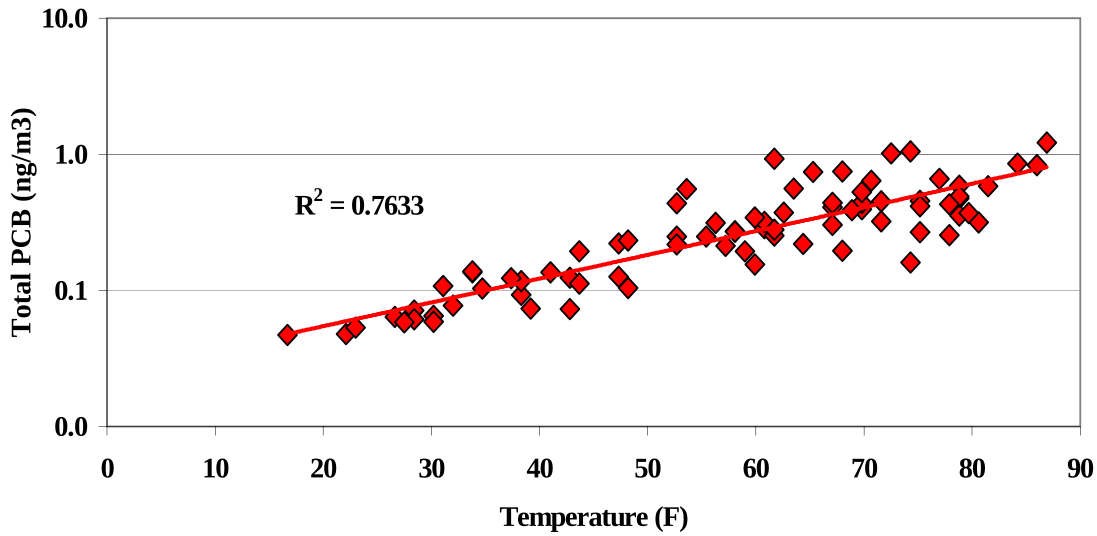


Figure 6.3 PCB air sampling at Sterling for the period April 2002 – March 2003 showing direct relationship between air temperature and amount of PCBs measured



Water Column Results

The criteria for including results shown in Table 6.3 were that the result had to be equal or greater than five-times the concentration observed in "blank" samples. PCB congener 11 was the most commonly found PCB and on the average was more than 20 per cent of the total PCBs. This congener is produced by dye manufacturers. Congeners 5, 8 and 18 were the next most commonly found.

Table 6.3 Total PCBs, DDE and Mirex in Lake Ontario Surface Water dissolved phase, ng/L (Average of 3 intensive sampling events: April and Sept. 2002 and July 2003)

PCBs *(ng/L)*	p-p' DDE *(ng/L)*	Mirex *(ng/L)*
0.093	**0.004**	**0.000**

Mercury Results

When inorganic forms of mercury (Hg) enter water, the mercury may be altered by bacterial or chemical action into an organic form, primarily methylmercury. Methylmercury is more toxic than the inorganic mercury, and has the ability to migrate through cell membranes and bioaccumulate in living tissue. Bioaccumulation of methylmercury in natural ecosystems is an environmental concern because it inflicts increasing levels of harm on species higher up the food chain. Through the biomagnification process, methylmercury increases in concentration from microorganisms, to fish, to fish eating predators, then to humans.

Atmospheric deposition is a major input route of mercury to the water. Atmospheric Hg is primarily emitted from natural and anthropogenic sources and exists mainly in three inorganic forms: elemental mercury (Hg°), reactive gaseous mercury (RGM) and particulate mercury. Hg^0 makes up more than 90 per cent of total gaseous mercury (TGM). It is inert, water insoluble and volatile. It is not readily removed from the atmosphere by wet and dry deposition, and has a long residence time in the atmosphere (approximately 1 year). It has an approximate homogeneous atmospheric concentration of between 1-5 ng/m^3.

Gaseous divalent mercury (Hg^{++}) is absorbed by cloud droplets, deposits more than 100 times as readily as Hg°, and has a short residence time in the atmosphere (a couple of days). In atmospheric water it tends to be present either dissolved or absorbed onto particles in droplets. Hg^{++} reacts to form water soluble compounds (e.g. $HgCl_2$ or $Hg(OH)_2$) and is then referred to as reactive gaseous mercury (RGM). RGM concentrations can vary from 1-600 pg/m3, depending on location, and make up about 3 per cent of total gaseous mercury in the atmosphere. Particulate mercury consists of mercury associated with atmospheric particulate matter and makes up less than 1 per cent of total mercury in the atmosphere. It can contribute significantly to atmospheric deposition due to its short lifetime (a few days). In the water column, Hg^{++} can be methylated, buried in sediments or re-suspended from the sediments.

As part of the LOADS project, four types of mercury were measured: TGM , which consists of both Hg^0 and RGM in the atmosphere; RGM in the atmosphere; TGM in the water column (filtered and unfiltered); and dissolved gaseous mercury (DGM) in the water column. TGM and RGM concentrations were measured onboard the R/V Lake Guardian, at Sterling, New York in April and September 2002, and July 2003 and at the IADN station , Pt. Petre, Ontario in Sept. 2002 and July 2003. Results are reported in Table 6.4.

RGM is produced by sources that directly emit it to the atmosphere. Variations in RGM concentrations were large, consistent with RGM being a more local pollutant than Hg^0. RGM concentrations measured at some of the sites when the ship was located near Toronto were significantly higher than samples collected at other locations in September 2002 and July 2003, but this trend did not occur in April 2002, possibly due to varying wind directions.

Overall, there was no consistent trend in TGM or RGM between the western part of the lake and the eastern part of Lake Ontario.

Both unfiltered and filtered TGM samples were collected from the Lake Guardian. The unfiltered and filtered TGM concentrations were consistently higher in western Lake Ontario than in eastern Lake Ontario, with the exception that similar filtered TGM concentrations were measured in both areas in July 2003. Results are reported in Table 6.4. Dissolved gaseous mercury (DGM) which consists mainly of Hg^0 in surface water were found to be higher in western Lake Ontario than those measured in eastern Lake Ontario.

Table 6.4 Concentrations of Total Gaseous Mercury (TGM) and Reactive Gaseous Mercury (RGM) in Air and filtered Total Gaseous Mercury (TGM) and Dissolved Gaseous Mercury (DGM) in the Water Column of Lake Ontario

Analyte	Units	Sample Date	Western Basin	Eastern Basin	Land-based Site Sterling, N.Y.	IADN Site Pt. Petre, Ont.
TGM	ng / m^3	April 02	1.86	1.79	1.99	1.67
		Sept. 02	1.75	1.52	7.43	1.61
		July 03	1.55	1.71	3.01	1.97
RGM	ng / m^3	April 02	3.80	19.82	7.59	NA
		Sept. 02	8.50	5.83	3.72	6.31
		July 03	5.32	5.62	7.39	3.98
TGM (unfiltered water)	ng/liter	April 02	0.45	0.33		
		Sept. 02	0.23	0.16		
		July 03	0.36	0.26		
TGM (filtered water)	ng/liter	April 02	0.30	0.19		
		Sept. 02	0.22	0.16		
		July 03	0.23	0.24		
DGM	pg/liter	July 03	17.46	13.64		

Dioxin/Furan Results

One of the objectives of the LOADS project was to compare the air concentrations over land vs. over water. The summary results of air concentrations (Table 6.5) below shows the total concentration of dioxins/furans at the land based site was greater than that measured over water. Another objective of the LOADS project was to compare the western basin of Lake Ontario to the eastern basin. The observation that the western basin has higher dioxins/furans that the eastern basin for all three periods suggests that the urban areas ringing the western portion of the lake (e.g. Toronto, Hamilton Harbor, Niagara Falls, and perhaps Buffalo), may be a significant contributor to the dioxins/furans measured here. Accordingly, these urban areas may be important sources for the atmospheric deposition of dioxins/furans to Lake Ontario. The land based site which has higher dioxin/furan concentrations may be influenced by nearby urban areas.

Ten water column samples, representing 4000 L of filtered lake water, were combined and analyzed for dioxins/furans. The total was not significantly greater than the ship field blank of 0.4 pg/L. This is not surprising, since it is widely hypothesized that the majority of dioxins/furans in the water column are to be found absorbed to suspended particulates. During the LOADS project, the glass fiber filters used to filter the water were frozen and archived. Future plans include developing a procedure to analyze these filters and measure the concentration of dioxins/furans in the Lake Ontario water column particulate phase.

Table 6.5 Total Dioxins / Furans air concentrations (pg/m^3) LOADS three intensive sampling periods

Sampling Location	Aboard R/V Lake Guardian in Lake Ontario Western Basin	Aboard R/V Lake Guardian in Lake Ontario Eastern Basin	Land-Based Sterling, NY
April 2002	0.45	0.23	0.97
Sept. 2002	0.62	0.25	0.75
July 2003	0.64	0.46	0.74

6.5.1.3 Great Lakes Binational Toxics Strategy

The Great Lakes Binational Toxics Strategy: A Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances (hereafter the GLBTS) was conceived in response to the International Joint Commission's (IJC) Seventh Biennial Report on Great Lakes Water Quality, 1994. The IJC, the independent body of government-appointed commissioners with the responsibility to assist and evaluate US and Canadian efforts under the Great Lakes Water Quality Agreement (GLWQA), called upon the two governments to "…adopt a specific, coordinated strategy within two years with a common set of objectives and procedures for action to stop the input of persistent toxic substances into the Great Lakes environment."

Signed in 1997, the GLBTS is a binational partnership agreement between Canada and the United States to virtually eliminate persistent toxic substances from the Great Lakes environment through pollution prevention and toxic reduction activities. GLBTS "Level 1" substances include all the Lake Ontario critical pollutants (mercury, PCBs, dioxins/furans, DDT, mirex and dieldrin) as well as hexachlorobenzene, benzo(a)pyrene, octachlorostyrene, alkyl-lead, chlordane and toxaphene.

EC, the USEPA, and stakeholders from industry, academia, state/provincial and local governments, Tribes, First Nations, and environmental and community groups have worked together toward the achievement of the Strategy's challenge goals. Of 17 GLBTS reduction goals set forth for the 12 level I persistent toxic substances in April 1997, 9 have been met, 4 will be met by the target timeline date of 2006, and the remaining 4 will be well advanced toward meeting their targets by 2006.

For more information, please visit www.binational.net.

6.5.1.4 Lake Ontario Mass Balance Models

Mass balance models are developed to relate loadings of toxic contaminants to the lake to levels in water, sediment, and fish. These models provide an initial technical basis for determining load reduction targets, estimating how long it will take to meet these targets, and planning for additional measures necessary to achieve load reduction goals. One of the benefits of a Lake Ontario mass balance modeling effort is an improved ability to quantify the relationship between the mass loading of contaminants of concern to the lake and their concentration in water, sediments and biota. This information could then be used by the LaMP to help determine the most effective source reduction strategies. Some of the management questions that can be addressed include:

- What is the relative significance of each major type of source discharging toxic contaminants into Lake Ontario?
- How will contaminant levels in the lake and its biota respond to changes in contaminant loads and how long will it take?
- What is the effect of toxic contaminants already present in the sediments?
- Can observed trends in toxic contaminants over time be explained and can future trends be predicted?

With USEPA support and in coordination with the LaMP, a group of researchers led by Dr. Joseph V. DePinto of LimnoTech, Inc. have developed a mass balance and bioaccumulation computer model called LOTOX2 that can be used to assess the effectiveness of various load reduction scenarios aimed at reducing toxic contamination in the lake water, sediments, and sportfish.

Because contaminant loads are required inputs to the model, early efforts in the development of this model focused on obtaining contaminant load estimates for Lake Ontario and its tributaries. The first year results of the LOTOX project provided preliminary estimates of contaminant loads from all major source categories. When possible, these were calculated from primary data (e.g., monitoring data such as the Niagara River Upstream-Downstream Program); but frequently it was necessary to use published literature sources. Recognizing the uncertainty of many of the estimates, several sampling efforts have been undertaken to improve the loading estimates of Lake Ontario's critical pollutants and thus improve LOTOX2's predictive ability in forecasting the response of water, sediment and fish concentrations to load reductions

Efforts to reduce uncertainty in load estimates have proceeded along three tracks. Initial work focused on developing a history of tributary contaminant loading based on sediment cores collected by New York State Department of Environmental Conservation near the mouths of Lake Ontario tributary streams. Dated sediment cores provide a time history of contaminant accumulation at the location of the core. Using such cores, a method was developed to interpret the sediment accumulation data in a way that yields an estimate of the history of contaminant loading from the associated tributary. Additional information on current loadings from Canadian tributaries from the OMOE and EC tributary monitoring program was used to update tributary loading estimates.

Recognizing the importance of atmospheric deposition as a source of critical pollutants to Lake Ontario, air monitoring program over the lake supplemented ongoing monitoring supported by EC at the Point Petre, Ontario IADN site. In September 1998, Dr. Keri Hornbuckle, with support from USEPA as part of the LOTOX project, used the USEPA research vessel Lake Guardian to sample air and water at seven locations around the lake. The initial survey detected generally higher air and water PCB concentrations in the western end of the lake than in the east. This suggests the presence of PCB sources in the urbanized areas on the western end of the lake. In 2002, Dr. Thomas Holsen of Clarkson University and collaborators at SUNY Fredonia, SUNY Oswego and the University of Michigan with support from USEPA, embarked on the Lake Ontario Atmospheric Deposition Study to provide an estimate of atmospheric loadings of critical pollutants to Lake Ontario (see section 6.5.1.2). Currently, the data are being analyzed, and being transmitted to the modelers. Loading estimates will be made in the near future.

The third track of load estimation work focused on data from New York point sources that report their discharges pursuant to New York State Pollutant Discharge Elimination System (SPDES) requirements. This analysis assessed the contribution of 1) point sources; 2) non-point sources; and, 3) Lake Ontario watersheds. In other words, it provides an estimate of the fraction of a given tributary's loading that originates from point sources within its watershed.

USEPA began tributary sampling of the Genesee River, 18 Mile Creek, Oswego River, Salmon River and the Black River in 2002. Samples were taken in spring and fall 2002; spring, summer and fall 2003; and spring and fall 2004. The monitoring plan is planned to continue for the near future. The water samples are tested for total mercury, mirex, dieldrin, DDT, DDD, DDE, dioxins/furans and PCBs.

Using these historical reconstructed and present-day load estimates, the LOTOX2 model was calibrated for total PCB concentrations in Lake Trout (Figure 6.4), water column concentrations, and sediment concentrations. The calibrated model was confirmed by running the model through 2010 and comparing the output with new data for water column PCB concentrations, PCB lake trout concentrations, and sediment PCB concentrations collected in the period subsequent to the model calibration. All calibration and confirmation results, as well as the results of sensitivity analyses, loadings reconstruction, and a detailed discussion of model development and history are contained in the LOTOX2 model documentation report, *LOTOX2 Model Documentation in Support of Development of Load Reduction Strategies and a TMDL for PCBs in Lake Ontario* (Limno Tech, Inc. 2003).

In July 2003, an eleven-member peer review panel of modeling experts from academia, Great Lakes research institutes, USEPA, EC, NYSDEC, and OMOE met at a two-day workshop to critically review the LOTOX2 model, its documentation, and its intended use in forecasting Lake Trout PCB levels under a variety of load reduction scenarios. All reviewer comments and the modeler responses to these comments are detailed in the *LOTOX Peer Review Report* (USEPA, 2003). After the successful peer reviewer, LOTOX2 was used to run a number of sample management scenarios selected by the LaMP Parties. Figure 6.5 illustrates the model output from a few of these scenarios including the model's base forecast (that assumes a constant PCB load from all sources after 2000) and a cumulative source elimination scenario where point source, tributaries, Niagara River and atmospheric deposition are sequentially zeroed.

The results of these management scenarios provide important insights into the possible effects of PCB load reductions beyond what has already been achieved. The key insights gained from comparing these loading scenarios are that continued PCB load reductions are expected to produce in-lake benefits, in this case exemplified by lower PCB concentrations in lake trout; however, it will also take some time for those benefits to be realized. As can be observed in Figure 6.5, which illustrates the 2000 PCB mass balance for Lake Ontario, there is a significant reservoir of PCBs in Lake Ontario's sediment and a net flux of PCBs from the sediment into the water column. It is estimated that it will take 10-15 years for these internal process to achieve a steady state. Until that time, in-lake processes, in particular sediment feedback, acting on historical inputs of PCBs will govern the rate of decline and buffer the rate at which PCBs decline in the water column in response to decreasing external loads. Because of this response time, it will not only be difficult to distinguish between loading scenarios in the near term, but the benefits of PCB load reductions will not be realized for several decades. However, once equilibrium is reached, the steady state water column concentrations will become proportional to the external loading and the benefits of the load reductions will become apparent (Figure 6.5).

Sample Management Scenarios Run on LOTOX2

1. **Baseline "No Action" scenario:** constant load from all sources after 2000
2. **Onoing recovery scenario**: loads from all sources continue to decline at first-order rate based on previous 15 years
3. **Point source elimination** : zero all point sources (PS) with other loads held constant
4. **Tributary source elimination:** zero all tributary loads (including PS) while holding Niagara River and atmospheric sources constant
5. **Niagara River elimination:** zero load from Niagara River with all other sources held constant
6. **Atmospheric load elimination:** eliminate wet/dry deposition and zero atmospheric gas phase concentration with all other sources held constant
7. **Cumulative source category elimination scenario:** sequentially zero PS, tributaries, Niagara River, and atmospheric deposition
8. **Eliminate all external loads and atmosphere boundary condition**

Despite the fact that PCB concentrations in fish are still responding to the historical inputs of PCBs, the substantial decline in PCB concentrations depicted in Figure 6.5 for the "no action" scenario suggest the importance of banning PCB production and use in the 1970s. On average, lake trout in Lake Ontario today have PCB levels below 2 ppm. Furthermore, the scenarios indicate that continued load reductions will produce additional benefits to the lake, as reflected in the differences in the ultimate lake trout PCB concentrations among the scenarios.

Figure 6.4 Model Confirmation 1998 - 2001

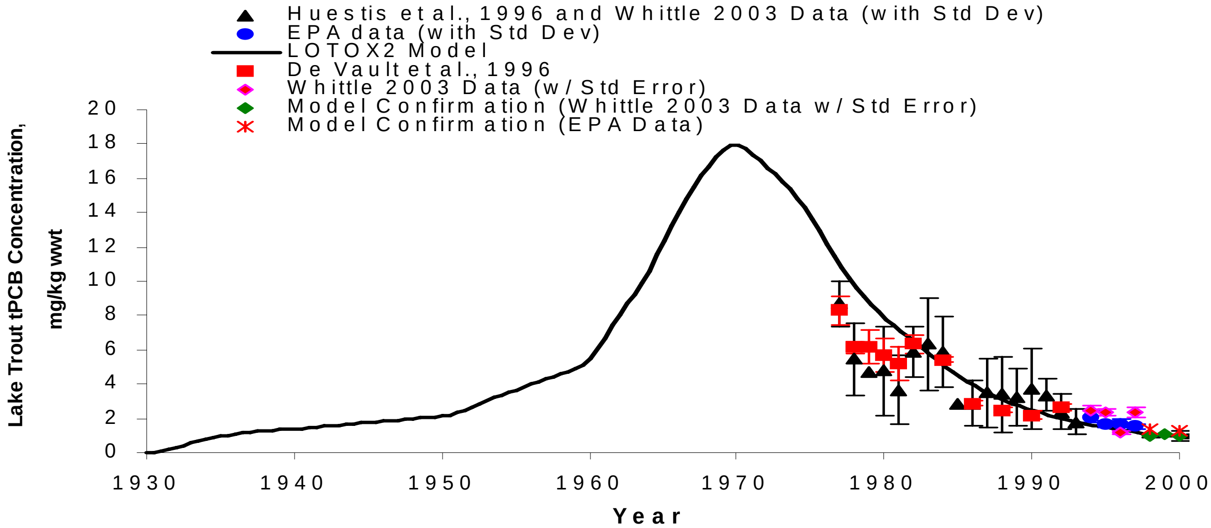


Figure 6.5 Output for Lake Trout PCB Concentrations under Baseline and Other Loading Scenarios

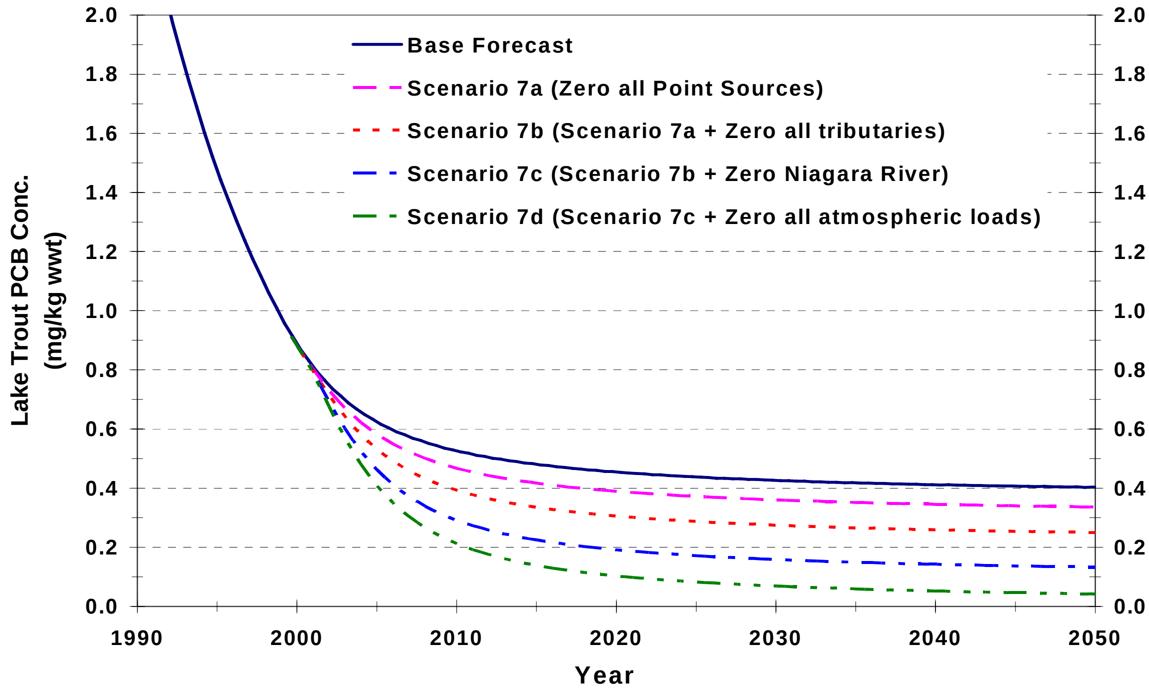
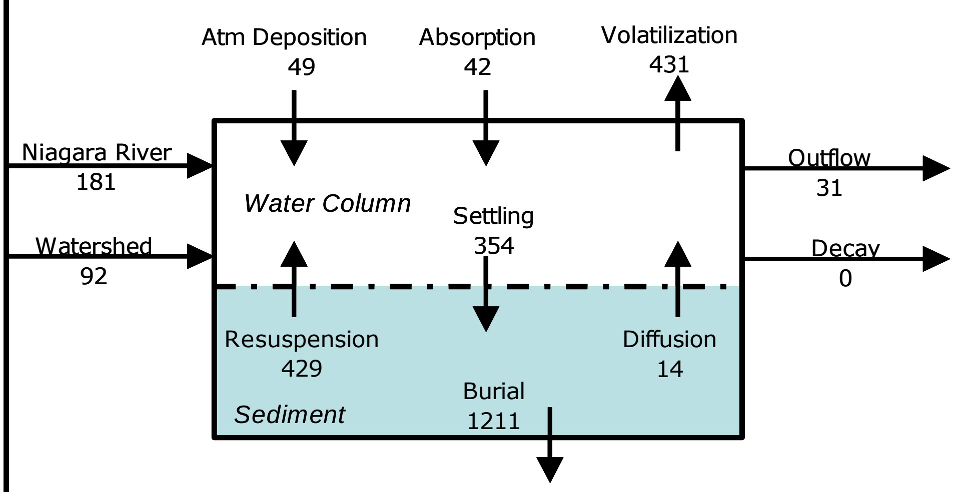


Figure 6.6 Lake Ontario PCB Mass Balance for the Year 2000.

Arrows represents the uptake and loss processes included in the LOTOX model. Numeric data provided are in units of kilograms per year (kg · yr^{-1}). The figure indicates that on an annual basis, the system loses approximately ~1300 kg of PCBs, with the main loss mechanisms being sediment burial (1200 kg yr^{-1}) and volatilization (430 kg yr^{-1}).



	Initial Mass (kg)	Final Mass (kg)	Change in Mass (Δ kg)
Water Column	271	262	(9)
Sediment	30 590	29 290	(1300)

6.5.1.5 Binational Sediment Workshop

In March 2004, the LaMP organized a binational sediment workshop that was held in East Aurora, New York. The workshop brought together sediment experts from Environment Canada, the US Environmental Protection Agency, the Ontario Ministry of the Environment and New York State Department of Environmental Conservation, as well as LaMP workgroup and management committee members. Experts shared results from a number of significant sediment surveys undertaken in Lake Ontario including:

- A comprehensive survey of sediment quality in Lake Ontario undertaken in 1997 by scientists from the USEPA, National Oceanic Atmospheric Administration (NOAA) and NYSDEC, intended to evaluate surficial sediment quality in the lake as a whole, establishing a baseline of environmental information by which future trends could be measured;
- A 1998 survey of Lake Ontario bottom sediments undertaken by EC's National Water Research Institute (NWRI) which repeated a 1968 EC survey, intended to determine any changes in the spatial, or geographic, distribution of contaminants over that time span;

- A nearshore sediment survey of harbours and embayments in Lake Ontario on the Canadian side including the Canadian Areas of Concern, which was undertaken in 2000 by OMOE scientists,; and,
- Sediment surveys undertaken by NYSDEC where sediment from the nearshore of Lake Ontario on the US side, including tributary sediment cores were collected and analyzed.

The objectives of the workshop were: to share the results of the open water sediment surveys as well as nearshore sediment investigations carried out by the Four Parties; to improve our understanding of the nature and significance of sediment sources of critical pollutants to Lake Ontario; and, to reach consensus on next steps with respect to a binational sediment monitoring program. Presentations and discussions focused on: A) Open Water; B) the Nearshore; C) Integration of Results; and D) Next Steps. The following is a summary of the presentations and results of the workshop:

A) *Open Water* – What is the nature and significance of open water sediment sources of critical pollutants? What is known, what is not known and what are the management implications?

<u>Presentations</u>

- Spatial and Temporal Trends in Contaminants in Lake Ontario -- Chris Marvin (EC), Alice Dove (EC), Scott Painter (EC)
- Surficial Sediment Quality in Lake Ontario -- Dick Coleates (USEPA)

<u>What is known</u>

- There is no acute toxicity anywhere in open water.
- Sediment quality has improved from the 1960s to the 1990s. Generally, levels have gone down 60-70 per cent (mercury 25-75 per cent; PCBs 40 per cent; dioxins 70 per cent; total DDT 60 per cent). Lindane and dieldrin are ubiquitous, and are found in similar concentrations; USEPA did not detect either parameter. HCB, OCS and mirex patterns suggest localized sources.
- LaMP critical pollutants concentrations are frequently greater that the Ontario Provincial Sediment Quality Guidelines' lowest effect level (LEL), but less than its severe effect level (SEL); values approach the probable effect level (PEL- the concentration at which effects are likely to occur) from the Canadian Sediment Quality Guidelines. EC results were similar to USEPA results.
- The Lake basins are very homogeneous – differences are due primarily to bathymetry, with contaminant levels generally higher in deeper basins.
- Fish consumption advisories are being driven by PCBs and dioxins/furans.
- Lake Ontario open water sediment chemistry levels are still the highest among the Great Lakes.

<u>What is not known</u>

- Emerging chemicals (e.g., PBDEs). There are some limited data on sediment concentrations of other emerging chemicals of concern (e.g., brominated flame retardants, polychlorinated naphthalenes) in Lake Ontario (see section 10.5). The extent and range of emerging chemical concentrations in Lake Ontario's sediments is still largely unknown.
- Sediment chemistry is only part of the picture. Sediment quality guidelines are not linked to food web effects.

B) *Nearshore* – What is the nature and significance of nearshore sediment sources of critical pollutants? What is known, what is not known and what are the management implications?

Presentations

- New York Lake Ontario Basin Contaminated Sediment Issues – Fred Luckey (USEPA), Frank Estabrooks (NYSDEC)
- Sediment Quality in Lake Ontario Harbours and Embayments – Lisa Richman (OMOE), Camelia Rusmir (OMOE), Duncan Boyd (OMOE)

What is known

- The most contaminated sediments in Lake Ontario remain largely confined to the already identified Areas of Concerns. Some smaller areas of highly-contaminated sediments and some ongoing sources do remain, but both are addressed as they are encountered (see Contaminant Trackdown, Sections 6.5.2.1 and 6.5.3.1).
- The nearshore zone is very dynamic and variable, which is important for design of sediment sampling programs.
- On the US side- focus is on Areas of Concern (18 Mile Creek , Genesee River (silver), Oswego) and major tributary watersheds (e.g., Black River (DDT)) where sources are being addressed.
- On the Canadian side, lots of data on harbours and embayments. Surprises included Whitby Harbour (dioxins/furans) and Niagara (DDT- active source suspected), but overall problems are being addressed.

C) *Integration of Results* - How can we integrate the results of the surveys? What's missing/what additional data is available? Is the data compatible?

Presentations

- Integrated Mapping of Results by Environment Canada -- Scott Painter (EC), Alice Dove (EC)
- Tributary Screening- Alice Dove (EC)

Summary

- Agreement-in-principle amongst the workshop participants on the need to share/pool data and develop a screening level map, integrating the results of the various sediment surveys.
- Workshop participants agreed that a project be scoped out by the LaMP Workgroup for Management Committee approval (including the resources required).
- Based on the Lake Erie LaMP experience, where it took one person four years to assemble all the data, the preferred approach would be for one of the Four Parties to take the lead and have each agency assign technical staff to the project work with their own data so that they can be provided in a specified format and address technical issues as they arise.

D) *Next Steps* – What is the timing and need for next sediment survey? Are there other approaches to consider?

Presentations

- A Proposal to Develop a Binational Approach to Monitoring Contaminant Trends Using Radiodated Sediment Cores- Lake Ontario LaMP – Fred Luckey (USEPA)

Summary

- Agreement-in-principle amongst workshop participants on a draft proposal by USEPA for adopting a binational approach to monitoring contaminant trends using radio-dated sediment cores. The proposed approach is to use dated sediment cores and surficial sediments to infer potential harm to ecosystems, track progress in reducing inputs of critical pollutants and to identify new contaminants of concern.

- This approach would replace the need to undertake another intensive spatial survey, as was done by EC (1998) and USEPA (1997). EC's NWRI is willing to provide in-kind support to collect and radio-date the cores, but will require approximately $50K for chemical analyses.
- The LaMP is implementing the proposed approach of monitoring contaminant trends using radio-dated sediment cores. Details and status are provided in the LaMP workplan.

6.5.2 U.S. Activities

6.5.2.1 Contaminant Trackdown

Information on critical pollutant sources and related problems has been synthesized and used to plan environmental monitoring /sampling which in turn is used to identify and confirm suspected pollutant sources for following up investigation and possible remedial action.

NYSDEC and USEPA conduct a wide variety of environmental investigations across the Lake Ontario basin, evaluating critical pollutant concentrations in water, sediment, fish, and biological samples. Much of this sampling has been guided by reviews of existing information and recommendations provided by core environmental program monitoring and/or other special purpose environmental monitoring activities.

For example, inactive hazardous waste sites in the basin were ranked based on their potential risk to nearby surface waters. Surface waters adjacent to sites with the highest potential were sampled to identify any sites requiring additional attention. Similar approaches have been used to evaluate potential areas of sediment contamination, contaminants in surface water discharges, fish tissue contamination and the effectiveness of remedial actions.

Other types of contaminant trackdown activities include sampling receiving waters and wastewaters at Publicly Owned Treatment Works (POTW) using state-of-the-art technology capable of achieving extremely low (parts per quadrillion) detection limits for PCBs, pesticides and dioxins. These projects include participation by the treatment plant operators, local governments, NYSDEC and USEPA. Wastewater samples are also collected at strategic points within the sewer collection system in an effort to identify where the majority of critical pollutants originate within these systems. This information assists sewage treatment plant operators in applying for various grant funding to upgrade their treatment systems to improve the quality of their wastewater.

The work to date has developed a good understand of the location and extent of critical pollutant sources and problems in the U.S. portion of the basin. Key highlights of investigation results and critical pollutant control actions completed or underway in the various New York state Lake Ontario watersheds are summarized below.

Lake Ontario Western Watershed

The Lake Ontario western watershed consists of the minor tributaries and nearshore area that extends from the Niagara River watershed to the Genesee River watershed. This nearshore area is not heavily populated and therefore not considered a significant source of contamination to Lake Ontario. The tributaries and historically identified sources of pollution in this nearshore are:

Eighteenmile Creek – Twelve miles upstream from where the RAP Area of Concern enters Lake Ontario, contaminated sediments are located near the City of Lockport downtown area and in the Barge Canal and its tributaries. These sediments have moved downstream and are trapped behind the Newfane and Burt Dams. The Williams Street Island (Flintkote Site) has PCB sediments in the creek bed.

The Lockport wastewater treatment facilities have been upgraded with New York State Environmental Bond Act and Great Lakes Protection Funds to address the sewage collection system, combined overflows and related stormwater. With RAP coordination activities now led by the Niagara County Soil & Water Conservation District starting in 2005, data synthesis, trackdown, and remedial measures in the AOC and watershed are to be further assessed, reported on, and implemented.

Slater Creek – Follow-up sediment and water sampling conducted in 1998 and 1999 at several points along the creek attempted to identify PCB sources. Results showed that PCB concentrations in sediment and water to be low with no evidence of significant inputs of PCBs to the creek. Dieldrin was found to be slightly elevated in Young of the Year , water and sediment samples. The source of dieldrin may be historical use of this pesticide in orchards located in the headwaters of Slater Creek. Follow up sampling of resident creek fish targeted by anglers for consumption should be considered.

Genesee River Watershed

The Genesee River watershed has its headwaters in Pennsylvania and flows north across the width of New York State to Lake Ontario (about 157 miles or 253 km). It collects water from 52 tributaries and 6 lakes on the way to Lake Ontario. The watershed includes the 4 most westernmost Finger Lakes: Conesus, Hemlock, Canadice, and Honeoye. **-** The mouth of the Genesee River is approximately 75 miles (121 km) east of the mouth of the Niagara River and six miles (9.7 km) north of the City of Rochester. This area is also known as the Rochester Embayment Area of Concern. The Genesee River watershed consists of 2,400 square miles (6,216 square km) in New York and is inhabited by approximately 400,000 persons. The historic sources of pollution are:

Monroe County's Sewer Collection System – at Rochester, reevaluation of wastewater treatment and point source discharge limits according to Great Lakes Initiative and SPDES permit requirements including added pretreatment and pollution minimization provisions has occurred. Monitoring and remedial measures are ongoing and have included the interceptor system and Combined Sewer Overflow abatement. A cooperative federal, state and county contaminant trackdown project was conducted. One section in the western metropolitan area of Rochester was identified as having wastewaters high in PCB concentrations. Follow-up action for the Delphi automobile parts manufacturing facility was identified and groundwater remediation was implemented resulting in treated wastewater being discharged to the sewer system. Actions to address mercury discharged from the Taylor Instruments facility have been taken.

In addition, Monroe County Department of Health has implemented several pollution prevention projects to address mercury discharges form Hospital and dental clinic wastewaters. A guidance manual was developed and voluntary actions have resulted in mercury phase out, collection, and prevention efforts at many dental and hospital facilities.

Lake Ontario Central Watershed

The Lake Ontario central watershed consists of the minor tributaries and nearshore area that extends from the Genesee River watershed to the Oswego River watershed. This nearshore area is not heavily populated and therefore not considered a significant source of contamination to Lake Ontario. The minor tributaries and historically identified sources of pollution are:

Sodus Bay and Creek – Historic bay area and watershed activities consisting of poor management of pesticides resulted in contaminated runoff. Analysis of Sodus Bay sediment has not determined problems in the concentrations of pesticides or dioxins. YOY fish samples from Sodus Creek have shown total DDT levels exceeded criteria designed to protect fish-consuming wildlife. The bay and ponds along this nearshore area present a challenge for shoreline nuisance management conditions due to nutrients and other invasive species.

Seneca-Oneida-Oswego River Watershed

The average water flow into the Oswego Harbor from the Oswego River is 4.2 billion gallons 53.8 billion liters) (per day and includes runoff from its 5,100 square mile (13,209 square km) watershed. The waters of the Oswego River include the drainage from the Finger Lakes and agricultural lands as well as wastewater from many towns, villages, and small cities in the watershed.

The Oswego River watershed includes the Oswego-Oneida-Seneca three rivers system. Within this very large watershed, significant environmental cleanup and protection activities have been accomplished over the years. The result of widespread remedial measures and protection activities in the watershed has been to mitigate and/or eliminate sources of pollution entering or leaving the Oswego River AOC boundaries that can contribute to or cause local impairments.

Oswego River – A detailed assessment for potential sediment contamination in the Oswego Harbor, Oswego River and the Seneca River was carried out in 1994 in response to data needs identified in the Oswego RAP Stage II report. One particular area of interest was the status of historical releases of mirex to the Oswego River from an inactive hazardous waste site well upstream from the RAP Area of Concern. Information on benthic community structure richness, biological impairment and sediment toxicity, as well as sediment contaminant levels, was collected at key points along the river and depositional areas behind dams. With the exception of Oswego River's Battle Island area, sediment contaminant levels were found to be low, with little to no evidence of toxicity to benthos. Based on these findings, a more detailed sediment evaluation was conducted in the Battle Island area. Smaller "pockets" of buried, historical contamination have been located; however, none approach the threshold level for remedial measure action.

Lake Ontario Eastern Watershed

The Lake Ontario eastern watershed is a relatively small nearshore area with minor tributaries that extends from the Oswego River watershed to the Black River watershed. This nearshore area is not heavily populated and therefore not considered a significant source of contamination to Lake Ontario. The minor tributaries and historically identified sources of pollution are:

Wine and White Creeks – Wine Creek enters Lake Ontario approximately two miles east of the mouth of the Oswego River. White Creek flows into Wine Creek approximately one mile upstream of the lake. PCBs have been remediated at the Pollution Abatement Services inactive hazardous waste disposal site, located at the junction of Wine and White Creeks. The Fire Training Area facility is located on White Creek and is required to monitor PCBs in its storm water. An abandoned landfill is located upstream of this facility. The detection of some PCB release at the PAS and Fire Training Area has not been linked to an environmental impact and the significance of the level of detection requires continued assessment.

Black River Watershed

The Black River and smaller tributaries to the northeastern Lake Ontario shoreline drain about 2,500 square miles in north-central New York State. This area includes portions of the western Adirondack Mountains, the Tug Hill Plateau and lowlands along the Lake Ontario shore. The Black River itself drains 1,920 square miles (4,973 km). Land use is diverse but not intense. The eastern portion of the basin features the densely forested woodland of the western Adirondack Mountains. The primary land uses in this sparsely populated region are silviculture and tourism/recreation.

Black River PCB Trackdown – at Carthage and Watertown, the waterbody inventory and assessment was completed in 2005. Updating is to include revised status of Priority Waterbody strategies. Implementation of watershed and non-point source abatement activities continues while the evaluation of sources and further remedial measures is ongoing. A local PCB sediment source is known to exist below the Village of Carthage. Since the impact is not significant the remedial action here and in other isolated areas of the Black River remains under review. Shutdown of paper manufacturing facilities as well as upgrades at the Carthage/ West Carthage Municipal Sewage Treatment Plant have resulted in significant sampling result improvements in discharge waters as well as in the receiving waters of the Black River.

6.5.2.2 Government Activities

U.S. Great Lakes Regional Collaboration

In December 2004, President Bush signed an executive order directing USEPA to lead a regional collaboration of national significance for the Great Lakes. The collaboration is a unique partnership of key members from federal, state, and local governments, tribes and stakeholders for the purpose of developing a strategic plan to restore and protect the lakes. Over 1,500 people from government and nongovernmental organizations participated in drafting the strategy, which includes recommendations for action. The final strategy was released in December 2005.

The strategy for toxic pollutants is based on the goal to establish and maintain the chemical integrity of the Great Lakes Basin Ecosystem, as called for in the Great Lakes Water Quality Agreement.

The strategy seeks to: 1) reduce and virtually eliminate sources of current priority pollutants; 2) prevent new chemical threats from entering the basin; 3) develop a sufficient knowledge base to address toxic chemicals in the Great Lakes environment; 4) protect public health and engage the public to do its part in reducing Priority Toxic Substances, and 5) address international sources.

The strategy seeks to build upon the efforts of the Binational Toxics Strategy (BTS), the Lakewide Management Plans (LaMPs), and the Remedial Action Plans (RAPs) in Areas of Concern, and offers the following recommendations:

1) Reduce and virtually eliminate the principal sources of mercury, PCBs, dioxins and furans, pesticides and other toxic substances that threaten the Great Lakes basin ecosystem

2) Prevent new toxic chemicals from entering the Great Lakes basin.

3) Institute a comprehensive Great Lakes research, surveillance and forecasting capability to help identify, manage, and regulate chemical threats to the Great Lakes basin ecosystem.

4) Protect human health through consistent and easily accessible basin-wide messages on fish consumption and toxic reduction methods.

5) Support efforts to reduce continental and global sources of persistent toxic substances to the Great Lakes basin.

Great Lakes Water Quality Guidance

In February 1998, NYSDEC completed the adoption process and began to implement the regulations, policies, and procedures contained within the Great Lakes Water Quality Guidance (GLWQG). The implementation of the GLWQG will result in consistent state water pollution control programs throughout the US Great Lake States and will lead to substantial reductions in the loading of LaMP critical pollutants and other pollutants.

The GLWQG will play a major role in addressing all of the lakewide impairments identified in this document. The following illustrates how the implementation of the GLWQG by the eight Great Lakes States will significantly address these concerns.

- Restrictions on fish and wildlife consumption: The GLWQG requires that the eight Great Lakes States adopt human health criteria based on the consumption of aquatic life, which will result in the eventual elimination of restrictions on fish and wildlife consumption by humans. The GLWQG includes numeric human health criteria for 16 pollutants, and methodologies to derive cancer and non-cancer human health criteria for additional pollutants.
- Degradation of wildlife populations and bird or animal deformities or reproductive problems: The GLWQG requires that the eight Great Lakes States adopt wildlife criteria, which, once achieved, will result in the eventual elimination of degraded wildlife populations and bird or animal deformities or reproductive problems. The GLWQG includes numeric criteria to protect wildlife from four pollutants (PCBs, DDT and its metabolites, dioxin, and mercury) and a methodology to derive criteria for additional bioaccumulative chemicals of concern (BCCs) discharged to the Great Lakes system.
- Targeting the pollutants of concern, which are bioaccumulative and persistent: The GLWQG focuses on the reduction of 22 known chemicals of concern, including PCBs, dieldrin, DDT and its metabolites, and dioxin. In addition to requiring the adoption of numeric water quality criteria for BCCs and other pollutants, as well as the detailed methodologies to develop criteria for additional pollutants, the GLWQG also includes implementation procedures that will result in loading reductions of BCCs to the Great Lakes basin. These include requirements for the development of more consistent, enforceable water quality-based effluent limits in discharge permits (including requirements for pollution minimization plans to track down and eliminate sources of BCCs); the development and implementation of total maximum daily loads for pollutants that can be allowed to reach the Great Lakes and their tributaries from all sources; and antidegradation policies and procedures which further restrict new or increased discharges of BCCs.
- The Majority of the Loadings of these Pollutants are from other Great Lakes: Since the GLWQG will be implemented in all eight Great Lakes States, the loadings of the identified pollutants of concern will be significantly reduced throughout the entire Great Lakes basin. Therefore, the major source of the loadings of the pollutants of concern to Lake Ontario will be substantially reduced.

New York’s Water Comprehensive Assessment Strategy

New York State Department of Environmental Conservation’s Comprehensive Assessment Strategy applies a watershed approach as the basic organizing unit in developing water pollution control strategies. Statewide, a Waterbody Inventory is maintained for the numerous individual stream segments and lakes. A Priority Waterbodies List is further developed where designated beneficial uses of these waterbodies are categorized as threatened, stressed, impaired, or precluded. Annual monitoring, assessment, and strategy implementation activities are based on a five-year cycle of the “Rotating Intensive Basin Survey (RIBS)” program which tracks and facilitates watershed actions in each of New York’s 17 major watersheds. Each year 2 to 3 watershed cycles are re-started in the RIBS process while 2 to 3 watershed cycles are completed.

Lake Ontario watersheds include the following: 1) Niagara River-Lake Erie; 2) Genesee River; 3) Oswego-Seneca-Oneida Rivers; 4) Black River; 5) St. Lawrence River, and 6) Lake Ontario Minor Tributaries-Nearshore. In any given year, one or more Great Lakes watersheds are in each of the phases of the RIBS process. In conducting a watershed approach, local governments and stakeholders are involved in the monitoring, assessment, and implementation phases of the process. The goal is restoration and protection of a designated waterbody and the watershed. Grant funding, technical assistance, other federal, state or local agencies, and related watershed resources form a partnership to address the priority water and natural resource needs in a targeted watershed.

Under the RIBS program watershed assessments are used to update the Water Inventory and Priority Waterbodies List which summarize the water quality information and identify priority problems in rivers and lakes across the state. These assessments also provide a starting point for the development and implementation of watershed restoration and protection action strategies. These strategies involve coordinating agencies and stakeholders to focus grant monies, technical assistance, regulatory efforts and other resources to address water quality priorities and natural resource needs of a watershed. Information developed involving the LaMP, such as lake and tributary monitoring, directly supports the development of comprehensive assessment and action strategies for Lake Ontario watersheds

Developing watershed strategies is rooted in the 1998 federal Clean Water Action Plan that accelerated watershed restoration across the country. The Action Plan strives to fulfill the original goals of the 1972 Clean Water Act to accomplish fishable, swimmable, and safe waters for all Americans. The Action Plan lays out a broad vision of watershed protection, involving coastal and estuarine waters, fresh waterbodies, wetlands, groundwater, natural resources, and drinking water sources. Under the plan assessments and implementation schedules have been built on existing water program and natural resource initiatives (especially RIBS).

Many resources come to bear on each watershed to provide a comprehensive restoration and protection program addressing: point and nonpoint sources of pollution, storm water and sewer flows, land use, construction activities, stream corridor improvements, habitat protection and modification, fishery enhancement, agricultural management, nutrient and pesticide use, and pollution prevention.

Based on a number of water quality and natural resource factors and assessment, waterbody segments have been placed in one of four categories: 1) need of restoration; 2) meeting goals to sustain water quality, 3) pristine or sensitive aquatic area administered by government jurisdictions; and 4) insufficient information to assess water quality.

Total Daily Maximum Load (TMDL) for Lake Ontario

USEPA and NYSDEC are currently working together on the development of a watershed-based, pollutant management tool known as a “total maximum daily load” (TMDL). The *Clean Water Act* requires that TMDLs, which identify point and non-point sources of a pollutant, be developed for impaired waters such as Lake Ontario. The TMDL also identifies reductions in point and non-point loadings necessary to restore impairments. Presently, USEPA and NYSDEC are collecting and analyzing data, and refining a water quality modeling tool that will support the development of a TMDL (see paragraph 6.5.1.5, LOTOX2 mass balance model). The schedule for TMDL development will be made available to the public through future LaMP documents.

Pollution Minimization Plans (PMP) Guidance Manual

NYSDEC with the assistance of USEPA funding has developed a Pollution Minimization Plan Guidance Manual.

The goal of Pollution Minimization Programs (PMP) for New York State point source dischargers and industrial users discharging to publicly owned treatment facilities is to achieve effluent quality at or below the water quality based effluent standard. Achieving the stringent pollutant-specific water quality standards demanded by state, national and international water quality goals now requires extra effort and performance measures. The purpose of a PMP guidance manual for regulatory agencies is to assure that treatment facility managers are informed about what is required and understand the steps needed to demonstrate that a strategy is being implemented. Carrying out a PMP requires certain activities to be conducted and performance measures to be defined and assessed towards achievement of a pollutant-specific goal in an industrial sector process.

Monitoring and reporting are critical to a PMP and its steps are subject to regulatory oversight; however PMP goals are results-based. It is therefore the responsibility of the permittee to demonstrate continued progress towards achieving compliance with the goals.

This manual is intended to be a reference for use by those responsible for development of Pollutant Minimization Programs at wastewater treatment plants. It was developed cooperatively by the New York State Department of Environmental Conservation's Division of Water and the Center for Integrated Waste Management of the University at Buffalo (the Center). Funding for the development and distribution of the manual was provided by the United States Environmental Protection Agency through a grant to the New England Interstate Water Pollution Control Commission, which contracted with the Center.

Background: Great Lakes Initiative, Bioaccumulative Chemicals of Concern, and New York State's Water Quality Standards)

Recognizing the significance of the Great Lakes as a resource and also the challenges that the resource faced, USEPA and the Great Lakes states agreed in 1995 to a comprehensive plan to restore and sustain the health of the Great Lakes. The resulting Water Quality Guidance for the Great Lakes System is known as the Great Lakes Initiative (GLI). The GLI establishes minimum water quality standards, anti-degradation policies, and implementation procedures for protecting and improving the waters of the Great Lakes System. Particular emphasis in the GLI was placed on reducing the levels of toxics being introduced to the Great Lakes System, especially persistent and bioaccumulative toxics. Bioaccumulative is the term used to describe chemicals that do not easily break down, enabling concentrations in an organism to increase up the food chain. Thus, people and the animals, birds and fish that are at the top of the food chain are exposed to the highest levels of these toxics.

The GLI lists 22 bioaccumulative chemicals of concern (BCCs), including mercury, polychlorinated biphenyls (PCBs), dioxin, chlordane, DDT, mirex and 16 other highly bioaccumulative chemicals. Because BCC's are harmful at extremely low concentrations, permitted discharge levels frequently need to be set at a calculated water quality based effluent limit (WQBEL) that is below the Practical Quantification Limit. In such cases, analytical uncertainties make it impossible to be certain of providing the necessary protection of water quality by simple establishment of an effluent limit. One rational approach to permitting – and more significantly – protecting the environment in such circumstances is for the permit to require the discharger to submit a Pollutant Minimization Program (PMP).

A PMP can be defined as an organized set of activities focused on achieving the maximum reduction of the target pollutant in the facility's discharge through means other than treatment at the facility.

6.5.2.3 Pollution Prevention Partnerships

Medical and Dental Projects

In the Rochester Embayment watershed, the Monroe County, New York, Department of Health implemented a mercury pollution prevention program for hospitals and dental offices. The project, made possible by a grant from the US Environmental Protection Agency, was undertaken in cooperation with the University of Rochester's Strong Memorial Hospital, Department of Dentistry and Eastman Dental Center. The project was a response to concerns about the health impacts of mercury and new federal regulations that greatly reduce the amount of mercury that can be discharged from a municipal wastewater system or an incinerator.

The US Environmental Protection Agency Region 2 presented one of its 1999 Environmental Quality Awards to the Monroe County Health Department and the University of Rochester for their mercury pollution prevention project.

Health Care

In New York State, Strong Memorial Hospital replaced mercury thermometers with electronic thermometers, mercury-filled sphygmomanometers with aneroid devices, and mercury-filled GI tubes with tungsten filled tubes. Strong Memorial Hospital also discontinued using mercury containing laboratory reagents unless there is no adequate substitute. Non-medical products that contain mercury are being phased out. A specialized training program for hospital staff was developed. The experiences at Strong and extensive research led to the preparation of a how-to manual that was distributed to other hospitals in the Rochester Embayment watershed and, by request, to other parts of the US and Canada. The manual is entitled Reducing Mercury Use in Health Care: Promoting a Healthier Environment (1998). It is available on the web at www.epa.gov/glnpo/bnsdocs/merchealth/.

Dentistry

In New York State, techniques for handling and recycling dental amalgam were developed by the Health Department and University of Rochester dental facilities. A booklet and poster, "Prevent Mercury Pollution: Use Best Management Practices for Amalgam Handling and Recycling", were distributed to dental offices in the Rochester Embayment watershed. The booklet contents are also included in the hospital manual.

Agricultural Pesticide Clean Sweeps

USEPA is continuing its commitment to reduce inputs of agricultural pesticides into Lake Ontario, by funding the County of Erie to expand its Clean Sweep project throughout the Lake Ontario basin. Erie County will use the strategies that were successful in previous Clean Sweep projects to solicit new participating counties and will provide local project management teams with the guidance and technical expertise necessary for successful implementation of this program.

Over the years Ontario and New York have significantly reduced and eliminated stores of unwanted and unusable agricultural pesticides held by farmers and others by holding voluntary pesticide collection events commonly referred to as "Clean Sweeps." Combined Ontario and New York efforts have collected and safely disposed of more than 750,000 kg/1,650,000 lbs of pesticides, including LaMP critical pollutants such as DDT, dieldrin, and mercury-based pesticides - all potential non-point source pollution threats to Lake Ontario water quality.

The New York State Department of Environmental Conservation, in partnership with the New York State Department of Agriculture and Markets (NYSDAM), Soil and Water Conservation Districts, and the Cornell Cooperative Extension, is conducting a new round of agricultural pesticide collection efforts in the Lake Ontario basin as part of their "Clean Sweep NY" Program. The program provides an entirely legal and economical opportunity to dispose of all canceled, obsolete or otherwise unusable pesticides and any elemental mercury used by a dairy or food storage facility. Triple-rinsed plastic or metal pesticide containers will also be collected and recycled. This latest round of pesticide collection efforts has included two Lake Ontario basin counties that have never held Clean Sweeps before, Lewis and Jefferson.

The "Clean Sweep NY" Program hires a professional waste hauler to dispose of unwanted pesticides and elemental mercury; provides on-farm or on-site assistance, when needed; provides analytical services to identify unknown/unlabeled pesticide products; collects triple-rinsed metal and plastic pesticide containers for recycling; and provides on-farm pickup for predetermined structurally unstable containers. Collection efforts were held in the eastern Lake Ontario basin in Herkimer, Jefferson, Lewis, Madison, Oneida, Otsego and Hamilton Counties in the fall of 2004. Spring 2005 collections were held in east-central basin including Onondaga, Oswego, Cayuga, and Cortland Counties. Collections targeting the west-central part of the basin occurred the week of November 6-11, 2005 in Wayne, Monroe, Livingston, Ontario, Seneca, and Yates Counties.

This program is free of charge for New York growers and commercial applicators applying products to agricultural commodities. Other potential holders of pesticides such as applicators, local municipalities, and retail/distribution establishments can approach NYSDEC and request to participate in this program.

6.5.3 Canadian Activities

6.5.3.1 Contaminant Trackdown

Concentrations of total PCB in some Lake Ontario tributaries were found to exceed the Provincial Water Quality Objective of 1.0 ng/L in an OMOE 1997-98 study, which confirmed results from other investigations. In response, a commitment was made by OMOE to confirm these findings using an integrated high-frequency sampling approach to characterize typical concentrations of PCBs along with other priority pollutants including polynuclear aromatic hydrocarbons (PAHs), and organochlorine compounds (including DDT and mirex). This approach involved the collection of four-week composite samples made up of subsamples collected every six hours throughout the entire year, rather than relying on 10 to 15 grab samples to characterize annual conditions. In this way, a more complete range of seasonal hydrological conditions within the watershed would be taken into account. This approach was first applied to several Lake Ontario tributaries from July 2000 through June 2001.

As PCBs represent the primary contaminant responsible for many fish consumption advisories, they were chosen as the main target critical pollutant for a pilot study: "Project Trackdown." For selected tributaries, this study was to address: (a) quantifying upstream-downstream differences in total concentrations (and congener patterns where possible) of PCB in water, sediment, and juvenile fish tissue; (b) quantifying differences in biomonitored (caged mussel) tissue PCB concentrations and congener patterns at selected points throughout the watershed; and, (c) quantifying differences in PCB concentrations and congeners in semi-permeable membrane devices (SPMDs), which are passive samplers used to determine the relative "bioavailability" of PCBs at various sites. These devices act as an artificial substitute for fish tissue.

The objective of this pilot project was to develop and evaluate approaches for identifying ongoing PCB sources and to provide guidance for conducting future source trackdown projects. Three pilot watersheds, Twelve Mile Creek, Etobicoke Creek and Cataraqui River were selected from Lake Ontario tributaries where elevated PCB levels were known to exist and good screening level data for biota, water, and sediment were available from both provincial and federal studies (Figure 6.7). These included water quality and juvenile fish data from the 2000-01 and 1997-98 studies described above, along with previous data from the 1991-92 Toronto area six tributary study.

Figure 6.7 Ontario Tributary Source Trackdown locations.

Each source trackdown project has been conducted in a staged approach. The stages act to narrow down each system in either a spatial manner, or to confirm or rule-out suspected PCB sources. Each project has included the collection of multiple lines of evidence, including sediment, event-based water sampling, biota samples and semi-permeable membrane devices (SPMDs). A weight-of-evidence approach is then used to guide the interpretation of the collected information and the next phase of field sampling.

Environment Canada and the Ministry of the Environment provided an initial assessment of the trackdown initiative in an interim guidance framework for PCB Source Trackdown Projects (Environment Canada, 2003). The interim guidance framework includes four separate phases in the Trackdown processes. These phases are:

A. Planning: Information is gathered to assess a site as a potential PCB Trackdown site.

B. Source identification: A project plan is created to find out whether local anomalies exist within the watershed.

C. Compliance/remediation follow-up: When a potential or ongoing source is located, compliance and abatement actions would ensue.

D. Project evaluation and recommendation: Upon completion of the abatement program, or of contamination removal, the abatement area is revisited to assess whether efforts have been successful.

Activities are ongoing at each of the three projects in 2005. As data from the 2003-2005 field seasons are compiled, the information will be used to update the guidance framework with the acquired knowledge. The results to date of these trackdown activities are summarized in Table 6.5, and details of each project are provided below.

The project involves extensive sampling for PCBs in water, sediment, fish and caged mussels at various locations along the tributaries to determine the sources of critical pollutants. The project will also try to determine whether sources of PCBs are historical or ongoing and locally controllable. Results will help determine the need for future measures and/or remediation actions that will ultimately reduce the amount of critical pollutants entering Lake Ontario.

Table 6.5 Phases of Lake Ontario Trackdown Studies

Project	Project start	Planning phase	Source identification	Compliance and remediation	Project evaluation and recommendations
Twelve-Mile Creek, St. Catharines and Thorold, ON	2000	Complete	Several ongoing sources identified. Further upstream work occurred in 2005 Endosulfan study initiated in Richardson's Creek as a result of Trackdown findings in small Tributary to Beaverdams Creek/ Lake Gibson area.	Working with the City of St. Catharines to locate on land sources of contamination into Old Welland Canal. Two former landfills currently under investigation. One company under preventative measures order to determine source of contaminated sediment in Beaverdams Creek. Endosulfan study initiated in Richardson's Creek as a result of Trackdown findings	Project success to be evaluated in 2007 Abatement stages in various phases
Cataraqui River, Kingston ON	Summer 2001	Complete	Two main areas of contamination identified. Contamination determined to likely be historic With the City of Kingston, groundwater determined not to be an ongoing major source	Sediment dredging project completed near the Emma Martin Park area completed in December 2004. Cooperative work with the City of Kingston determined that groundwater is not a likely ongoing source of PCB contamination. Determined that contamination likely from historical sources.	Success of dredging project to be evaluated during 2006-2007

Table 6.5 Phases of Lake Ontario Trackdown Studies

Project	Project start	Planning phase	Source identification	Compliance and remediation	Project evaluation and recommendations
Etobicoke Creek, Toronto, ON	2001	Complete	Two potential tributary outfalls identified as potential sources. Further work ongoing in 2005	Findings of the study likely to lead to abatement actions in sewer systems with Cities of Toronto and Mississauga.	Project success will be evaluated in 2008 pending initiation of compliance activities

Twelve Mile Creek

Twelve Mile Creek has a relatively small watershed and more than 95 per cent of the water entering the creek is Lake Erie water diverted through the Welland Canal.

Sampling by OMOE and EC conducted in 1997/1998 revealed total PCB concentrations (2.4 -12.3 ng/L) in water at the mouth of Twelve Mile Creek that were significantly higher than those observed in the Niagara River (Boyd and Biberhofer, 1999). These results suggested the possible existence of local PCB sources to Twelve-Mile Creek. Additionally, total PCB concentrations in juvenile fish (spottail shiners) collected at the mouth of Twelve-Mile Creek in 1997 were significantly higher than those collected at a nearby Lake Ontario beach.

Fieldwork specific to the PCB trackdown study started during the summer of 2000, with sediment and water samples collected at upstream and downstream sites of Twelve Mile Creek, including Lake Gibson. Mussels were deployed upstream of the confluence with Lake Gibson, downstream of Lake Gibson (in the vicinity of two outfalls discharging into the creek), at the power dam (Martindale Pond), and at a combined sewer outflow drainage ditch downstream of the power dam. Young-of-the-year shiners were collected from the upstream location, Lake Gibson and the downstream location (Martindale Pond). Caged mussels were also deployed at three sites along the Old Welland Canal: above and below a pulp and paper mill, and downstream close to the confluence with Twelve Mile Creek.

PCBs were shown to be bioavailable to the mussels at all of the sample locations. The concentrations of bioavailable PCBs increased in freshwater mussels with increasing distance downstream of Lake Gibson and the confluence with the Old Welland Canal. Follow-up investigations conducted with large volume water samples and caged mussels in 2002 identified several areas of the watershed that needed further study. PCB concentration in the mussel tissue was highest at an outfall used jointly by GM and the municipality of St Catharines. PCB tissue concentrations were similar between the upstream and downstream stations in the Old Welland Canal; however, congener pattern analysis suggests that there may be additional sources of PCBs entering the Old Welland Canal. The congener patterns observed in the Old Welland Canal were different from those observed in the mussels deployed at the municipal outfall by the GM plant, which had the highest PCB tissue concentrations. Downstream congener patterns from Martindale pond suggest a mixture of the Old Welland Canal and GM/municipal congener patterns. Although these preliminary biomonitoring results have succeeded in identifying potential sources of PCBs to Twelve Mile Creek, they are not sufficient to quantify their significance.

Young-of-the-year fish from Martindale Pond indicated an increase in PCB tissue concentrations compared to the upstream locations in Twelve Mile Creek and Lake Gibson. Interestingly, when the fish were normalized on a lipid weight basis, the PCB concentrations were similar to those in the mussels. PCB concentrations in Martindale Pond were elevated compared to concentrations observed at the upstream station on the southern side of Lake Gibson.

Based on these results, sampling in Twelve-Mile Creek in 2003 focused on three areas of the watershed: 1) Richardson's Creek; 2) Twelve-Mile/Old Welland Canal (OWC); and, 3) Beaverdams Creek and the Lake Gibson area. The purpose of the follow-up work in 2003 was to either discount each area as a likely source, identify outfalls that may contribute to further contamination or narrow down and identify stream stretches that would require further study. The 2003 sampling used up to four matrices (water, sediment, mussels, and SPMDs) to provide a weight-of-evidence approach for tracking down sources of PCBs.

Richardson's Creek data from 2003 showed no evidence of a PCB source. However, elevated levels of endosulfan (an insecticide) and its metabolites (an insecticide used to control the Colorado potato beetle, flea beetle, cabbageworm, peach tree borer, and the tarnished plant bug) were found in water samples. No further PCB trackdown was conducted in 2004 in the Richardson's Creek area; however, the identification of endosulfan initiated an additional trackdown-type study to determine the source of this contaminant.

The Twelve-Mile Creek – OWC stations tested in 2003 identified two feeder creeks as having potential upstream PCB sources linked to landfills. Follow-up work on these potential sources was started in 2004. Municipal and provincial governments are involved in abatement activities related to these landfills.

Beaverdams Creek findings suggest a source of waterborne contamination that may influence biota in the area. However, further work is required to determine whether there is an active source, or if the concentrations detected could be considered as typical background concentrations to the urban St. Catharines and Thorold areas. In the 2004 and 2005 field seasons, the Twelve-Mile Creek Trackdown study has shifted increasingly towards identifying sources of contamination entering the Lake Gibson system from smaller tributaries of Beaverdams Creek. Results from these studies are still pending.

Etobicoke Creek

Etobicoke Creek was selected for a PCB trackdown study as result of large-volume water sampling that showed elevated concentrations of PCBs in water compared to other tributaries in the Greater Toronto area (Boyd, 1999). The Etobicoke Creek watershed drains a total area of 211 km^2 (81.5 mi^2).The creek's headwaters are located within the City of Brampton and drain southward into Lake Ontario. The watershed is comprised of three main branches that flow through Brampton, Mississauga and Etobicoke.

Field work for the PCB trackdown started during the summer of 2001. Eleven locations along Etobicoke Creek were initially sampled, the majority of which were located at the mouths of the major tributaries into the main branch of the creek. The trackdown project included biomonitoring (fish and mussels), sediment collection, and large volume water samples integrated over a ten-week period. Environment Canada collected surficial sediment samples from the 11 sites for the study. Juvenile fish were collected from 9 of the 11 sites and caged mussels deployed at the locations where no fish were observed, as well as, upstream and downstream locations. As a result of the initial sediment screening, additional caged mussels were deployed at the mouths of two minor tributaries entering the main creek in areas of elevated PCB levels.

Activities in 2001 discounted various branches of the creek as sources of contamination. Two areas of focus were identified for study based on sediment and large volume water sampling. In 2002, SPMDs and caged mussels were placed upstream and downstream of discharges or outfalls within the area of interest. The results showed high concentrations near a tributary outfall draining an industrial area, with overall PCB congener patterns in mussels similar to conger patterns in SPMDs. Follow-up investigations were initiated in 2005 to investigate all inputs leading into the creek from this small tributary. Currently, a large storm sewer output is also being investigated as a potential source of PCB contamination to Etobicoke Creek, and several other areas of investigation have been identified for future work.

Cataraqui River

A 1994 OMOE study located PCB contaminated sediments in Kingston’s inner harbour and the Cataraqui River. The closed Belle Island landfill was identified as a former source of PCBs, with scrap yards, contaminated sites (brownfields), and industry discharges as potential additional sources. Contamination in the sediments of the Cataraqui River was greatest on the west side of the river, where urban and industrial activities historically occurred.

As a result of these findings, the trackdown study was initiated in 2001 to determine if sources are historic or if they are ongoing. Work focused on the west side of the river, and included biomonitoring using caged mussels, large volume water samples integrated over a ten-week period and collected directly from the municipal sewer pipes, and sediment core sampling. Caged mussels were deployed at the mouth of six municipal sewers discharging into the west-side of the river, and four caged mussel experiments were deployed in other areas of concern and at an upstream reference location. Sediment core samples were collected from six storm sewers on the west side of the river, and 26 core samples were collected from the south west side of the landfill in an attempt to spatially quantify PCB levels in this area. More intensive sediment sampling was undertaken in an area immediately south of the landfill and adjacent to an old tannery property, based on PCB levels observed in earlier sediment core studies. Results from the 2001 work confirmed a number of potential sources of PCB (either past or ongoing) to Cataraqui River, which included historically-contaminated sediments. Storm sewers were shown to not be a likely significant source of recent PCB contamination to the Cataraqui River and Kingston Harbour.

Based on results from 2001, the following objectives were developed to guide the 2002-2003 sampling program: 1) to determine where there was ongoing contamination into the Cataraqui River; 2) to assess if re-suspension of historically contaminated sediments contribute to bioaccumulation and mortality; and 3) to assess bioaccumulation in young of the year fish and sportfish near Belle Island Landfill, the tannery and Emma Martin Park in key locations using caged mussels and young of the year fish.

Results from 2002 for PCBs in Cataraqui River sediments showed that concentrations were highest near the southeast arm of the closed Belle Island Landfill, however elevated concentrations in sediment were also found near the former tannery and near Emma Martin Park. PCBs in SPMDs and fish in 2002 showed that the landfill and Emma Martin Park areas had elevated concentrations, which in turn agreed with 2001 data for caged mussels and juvenile fish collected from the same area. PCBs in benthic invertebrates for 2002 exceeded CCME guidelines for PCBs for the protection of mammals and birds that consume aquatic biota. Follow-up sampling in the fall of 2003 identified elevated PCB concentrations in the biologically active sediment layer (0-10 cm) between the docks located near at Emma Martin Park.

As a result of these findings, the removal of this contaminated sediment ‘hotspot”‘ near Emma Martin Park was planned, with the goal of reducing biological exposure from this active source. Emma Martin Park was a good candidate for rapid remediation because there was potential for sediment disturbance from the activities of a local rowing club, and it was a relatively small and confined area of higher contamination and with potential for biological uptake. Prior to remediation, a near-shore groundwater assessment was funded by OMOE to establish that there was no ongoing off-site contamination. A sediment delineation study established the depth and volume of sediment that would need to be remediated. A screening-level Human Health Risk Assessment also established that past exposure to the sediment presented no undue risk to Kingston Rowing Club members or area users.

Funding for the planning and implementation of the remediation project was provided by OMOE, EC, Transport Canada, and an in-kind contribution from the City of Kingston, totaling just under $350,000. This project removed 780 cubic meters (1,020 cubic yards) of sediment containing not only PCBs, but also containing mercury, arsenic, chromium and lead. This reduced the PCBs in sediment of this area to local background concentrations. Future monitoring will assess the effectiveness of the dredging at reducing local-scale biological uptake of PCBs in the Cataraqui River and reducing PCB loadings to Lake Ontario

Whitby Harbour

An OMOE source track down study in 2000 for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, identified high concentrations of these compounds in sediment within Pringle Creek, at the mouth of the Creek and at stations downstream of the creek in Whitby harbour. Data from additional studies in 2001 and 2004 suggested that the flood plain in a portion of the creek was also contaminated. Caged mussel data and indigenous juvenile fish data showed that the dioxin and furan contamination in the creek and harbour sediment was bioavailable. These studies are continuing in 2005 to identify all possible sources of dioxins and furans to the harbour as well as a review of options for site remediation and possible next steps.

Trent River Trackdown

As part of the ongoing monitoring work to assess sediment quality and to determine the need for sediment management actions within the Bay of Quinte Area of Concern, comprehensive sampling of the sediment was undertaken in 2000 and 2001. Analysis of the sediment samples taken by EC at the mouth of the Trent River found dioxin/furan levels higher than other sediment samples collected within the Bay of Quinte. As a follow up, in November 2004, six additional samples were taken by EC in the vicinity of the original samples at the mouth of the Trent River. Significantly elevated levels of dioxins/furans were found in the 2004 samples. A cooperative multi-agency initiative with representation from the Ontario Ministry of the Environment, Environment Canada, Lower Trent Conservation, Quinte Remedial Action Plan, Ontario Ministry of Natural Resources, City of Quinte West and the Hastings, Prince Edward Counties Health Unit, is underway to determine the source and the potential environmental and human health effects of these elevated levels. Specific actions to date include:

- The OMOE's Environmental Monitoring and Reporting Branch is currently conducting a source identification and bio-monitoring study of the lower Trent River.
- EC and OMOE conducted further sediment core and surface sampling the week of November 28th, 2005.
- The OMOE's Safe Drinking Water Branch, conducted dioxin/furan sampling at the Quinte West and all downstream Bay of Quinte water treatment plants on September 28, 2005. Results were received October 12, 2005. As expected, dioxins and furans were not detected.
- Dillon Consulting Limited has been retained to undertake a screening level human health risk assessment.
- Environment Canada and the Ontario Ministry of the Environment are undertaking an ecological risk assessment.

Also in response to these findings, the Trent River Mouth Investigation Steering Committee has been formed. It includes representation from OMOE (Chair), EC, City of Quinte West, Hastings, and Prince Edward Counties Health Unit, Lower Trent Conservation Authority, the Bay of Quinte RAP Restoration Council and the Ministry of Natural Resources. The purpose of the committee is to determine the sources and significance of the dioxin/furan contamination and any remedial action that may be required. It is proposed that a Screening Level Human Health Risk Assessment and an Ecological Risk Assessment be undertaken to evaluate any potential human health or ecological impacts.

Screening Level Surveys of Lake Ontario Tributaries

Screening-level surveys of the quality of recently-deposited sediments was undertaken in the summers of 2002 and 2003 near the mouths of tributaries draining from the province of Ontario to the Niagara River, Lake Ontario and the St. Lawrence River up to the Quebec border (Dove et al., 2003; Dove et al., 2004). A total of 244 samples was obtained, representing 211 tributaries and 26 field blanks. This screening-level survey was based on the *Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants*, developed by the United States Geological Survey for the US National Water-Quality Assessment Program (Shelton and Capel, 1994). A number of sub-samples are obtained to represent overall tributary conditions.

The samples were analysed for organochlorine compounds, Total PCBs, four PCB Arochlor mixtures, 27 metals and 16 polycyclic aromatic hydrocarbons (PAHs), as well as organic carbon content and grain size distribution of each sample. For many of the tributaries, this study represents the first information related to organic compounds in the sediments. Results were compared with the available Canadian Environmental Quality Guidelines for Sediment, and to Ontario's Provincial Sediment Quality Guidelines.

Results for Lake Ontario LaMP critical pollutants are summarized below:

- One or more PCB Aroclors were detected in about 50 per cent of the sites sampled; of those sites, approximately half of those had concentrations of PCBs above the Canadian "Threshold Effect Level."
- DDT or its metabolites were detected in about 50 per cent of the sites sampled, although DDT and its metabolites were much more prevalent in the western end of Lake Ontario than the eastern; more targeted studies are recommended to determine if ongoing sources of DDT exist in these watersheds;
- Dieldrin was detected in 8 tributaries (4 per cent) of Lake Ontario, all located in the western end of the Lake, in small tributaries located in urban areas;
- Mirex was only detected in the sediments of Stony Creek, and at levels below the Provincial Sediment Quality Guideline's "Lowest Effect Level"; and,
- Mercury, a naturally-occurring element, was detected in all tributaries to Lake Ontario, but typically at very low concentrations; only 15 of the 218 sediment samples had concentrations that were above naturally-occurring background concentrations.

These results are being used to determine relative contamination in tributaries of Lake Ontario and St. Lawrence River, and will be used in prioritizing any future contaminant trackdown activities.

6.5.3.2 Government Activities

Mercury

Regulatory efforts to reduce releases of harmful pollutants such as mercury have included the following:

- Ontario Regulation 196/03 required Ontario dental clinics (that place, repair, or remove amalgam) to install separators by November 15, 2003. Preliminary results from the Royal College of Dental Surgeons of Ontario indicate that approximately 99 per cent of the 7,800 dentists in Ontario appear to be in compliance with the regulation. The installation of amalgam traps/filters reduces loadings to the municipal sewer systems substantially and immediately.

- Ontario Regulation 323/02 required existing hospital incinerators to close by December 6, 2003; these closures have been verified by OMOE staff. Hospital incinerators were the fourth largest emission source of mercury in the province.

Ontario has implemented the Canada Wide Standards (COWS) for mercury emissions from hazardous waste incinerators. Notices amending the Certificates of Approval for these facilities to include the mercury CWS limit (50 µg/m^3) were issued prior to the end of December 2003.

The Ontario government is moving forward with a 2003 commitment to phase out coal fired generating stations (GS) in the province and replace this energy loss with cleaner more diversified power. The government has set in motion 7,605 megawatts of capacity additions to help support the replacement of coal including wind, hydraulic, natural gas cogeneration, nuclear refurbishment and demand side management. Under the coal replacement plan, five generating stations are to be replaced. Of significance to Lake Ontario are the closing of the Lakeview (closed April 2005) and Nanticoke (planned closure 2009) stations. The closing of these two coal fired generating stations will help reduce both smog causing pollutants and an estimated 259 kilograms/year (571 pounds/year) of mercury loading to the environment within the lake basin area, based on data provided by Ontario Power Generation.

PCBs

Environment Canada's PCB regulations are being amended and targeted for Canada Gazette publication in 2005. These regulations are:

1) *The Chlorobiphenyl Regulations* (1977)
2) *The Storage of PCB Material Regulations* (1992)
3) *Export of PCB Regulations* (1996)
4) *Federal PCB Destruction Regulations* (1989).

The most significant revisions to the regulations will be the imposition of strict phase-out dates for certain categories of PCBs. Revisions to the Federal PCB destruction regulations will see the strengthening of emissions release provisions mainly to bring the federal regulations in line with existing provincial requirements.

6.5.3.3 Pollution Prevention Partnerships

Dioxins and Furans – Uncontrolled Household Garbage Burning

Household garbage burning is estimated to emerge as the largest source of dioxin emissions after air emissions standards for industrial sources are in place. The practice of household garbage burning typically is carried out in old barrels, open pits, woodstoves, or outdoor boilers, and represents a significant source of dioxins and furans. To reduce loadings of dioxins and furans from household garbage burning, the Household Garbage Burning Strategy was developed in May 2001 under the Great Lakes Binational Toxics Strategy. The GLBTS maintains a website for information sharing at www.openburning.org.

In Ontario GLBTS partners have been implementing the Household Garbage Burning Strategy through public education workshops and public displays. In 2004 and 2005, 22 Burn It Smart! workshops were held in the Lake Ontario basin, promoting energy efficient USEPA certified wood stoves, the use of clean wood or alternatives, and not burning garbage. The workgroup is also working with municipalities and other non-government groups to distribute the Don't Burn Garbage fact sheet, as well as other fact sheets and videos on wood burning.

Mercury – "Switch Out" Program Continues to Expand

The "Switch Out" program was initiated in June 2001 to recover mercury switches from end-of-life vehicles. The program started with eleven auto recyclers in Ontario who collected approximately 2,500 switches in 2001. In 2004, four hundred auto recyclers in three provinces (Ontario, Alberta, and British Columbia) participated in a "Switch-Out Program" and over 58,000 switches have been collected.

Mercury – Appliance Switch Collection Program

In 2002, the Regional Municipality of Niagara conducted a pilot program to collect mercury switches from white goods (e.g. fridges, washers, dryers, etc.). Following a successful pilot program, an instruction manual and video were developed and the Association of Municipal Recycling Coordinators (AMRC) actively promoted the program with other municipalities. By 2003, several municipalities had adopted the program and AMRC estimated that 45 kg of mercury were collected in 2003. In February 2005, the AMRC hosted a mercury workshop for Ontario municipalities with a focus on programs that the municipalities could initiate.

Mercury – Dental Clean Sweep Launched

Based on a survey conducted by the Ontario Dental Association in 2001, it is estimated that nine per cent of Ontario dental practices have elemental mercury in their offices. A working group involving the Ontario Dental Association, the OMOE, EC and waste carriers developed an Ontario Wide Dental Elemental Clean Sweep Project to remove stores of elemental mercury from Ontario dental practices. The program ran until March 2005.

Mercury – Mercury Clean Sweep Program for Schools

Environment Canada and the Ontario Ministry of Environment are working together to implement a Mercury Clean Sweep Program for Schools. This program aims to safely remove stores of mercury-containing equipment and products from classrooms and science labs, and to reduce the potential for the accidental release of mercury into schools and the environment.

A pilot Clean Sweep Program was launched November 10 through 12, 2005 at the Science Teachers' Association of Ontario 2005 Conference. The program will run from January to March 2006. This pilot project is intended to gage the number of schools willing to participate in the program and to further determine the feasibility of hosting a province-wide Mercury Clean Sweep Project for Schools. Participating schools will be asked to perform an inventory of mercury-containing equipment or products in their classrooms and science labs. Collected mercury-items will be removed by waste management companies for proper disposal and recycling.

Ontario Waste Agricultural Pesticides Collection Program.

From November 22 to 23, 2005, Ontario farmers were able to take unwanted or old pesticides free of charge to 13 select farm supply dealers across Ontario. The Ontario Waste Agricultural Pesticide Collection Program provided free, safe disposal of de-registered, outdated or unwanted agricultural and commercial pesticides. The collected pesticides were sorted, recorded and packaged before being transported to an approved facility for safe disposal. Participants were also provided with helpful tips on reducing pesticide waste and other waste pesticide issues.

The program was funded by CropLife Canada, the Ontario Ministry of the Environment, Environment Canada and Agriculture and Agri-Food Canada through the Agricultural Adaptation Council's CanAdvance Program. The program was also supported by AGCare, the Ontario Agri Business Association and its network of participating agricultural dealers, and the Ontario Ministry of Agriculture, Food and Rural Affairs.

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